LIST OF EFFECTIVE PAGES

Chapter 6
DIMENSIONS AND AREAS

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*Pages revised, added or deleted by this revision.

Chapter 6
DIMENSIONS AND AREAS

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Chapter 6

DIMENSIONS AND AREAS

1. General

Airplanes are plotted about three reference planes: the longitudinal or X axis, the lateral or Y axis, and the vertical or Z axis. The plotting of the airplane, with respect to the reference planes, provides a means for locating components, distributing loads, determining the center of gravity, and coordinating manufacturing tools. A definitive system based on station lines, water lines, and buttock lines is used in locating components of the airplane. An understanding of this system, in addition to learning the location of the more obvious points in the fuselage, engine pods, wings, and empennage, will prove valuable in locating components on the airplane quickly. The following paragraphs and illustrations describe this locating system and present the principal dimensions and areas of the airplane.

2. Station Lines

Station lines are used as locations along the longitudinal axes of the fuselage, engine pods, or anti-shock bodies, the lateral axes of the wings and horizontal stabilizer, and the vertical axis of the fin or vertical stabilizer. Station lines are identified by their respective components, such as fuselage station lines, pod station lines, wing station lines, and the like, and are measured in inches from individual arbitrarily established zero reference planes.

Fuselage and engine pod station lines are measured horizontally from vertical reference planes established 100.0 inches ahead of the fuselage nose, and 38.0 inches ahead of the engine pod intake ducts, respectively. Anti-shock body stations are measured from zero reference planes at their theoretical nose tips. Wing stations are measured laterally from the centerline of the airplane and along the wing manufacturing chord plane, which has both a dihedral angle and an incidence angle with respect to the axes of the airplane. Horizontal and vertical stabilizer stations are measured along the natural chord planes of the surfaces from individually established zero reference planes.

3. Water Lines

Fuselage, wing, and empennage water lines (WL) are horizontal reference lines measured in inches vertically from a horizontal zero reference plane which is tangent to the inside surface of the fuselage skin at its lowest point on the airplane centerline. Thus, this lowest inside surface of the fuselage skin is at WL 0.0; all fuselage waterlines below this reference plane are negative or minus water lines. Fuselage water lines easy to remember are: WL 0.0 at the centerline of the airplane and on the inside surface of the fuselage skin at its lowest point, the top surface of the cabin floor at WL 59.0, and the six leveling rivets on both the left and right side outer fuselage skin surfaces at WL 68.0

Engine pod or nacelle water lines are measured in inches vertically from a horizontal zero reference plane which is 100.0 below the centerline of engine thrust. Thus, the centerline of engine thrust at each engine pod is on WL 100.0. WL 100.0 for the outboard engine pods is higher from the ground, and is also at a greater angle of attack, than WL 100.0 for the inboard engine pods.

4. Buttock Lines

Fuselage, wing, and empennage buttock lines (BL) are vertical reference lines parallel to the vertical centerplane of the fuselage and are measured in inches laterally, to the left or to the right, of a vertical zero reference plane which is at the centerline of the airplane. Thus, the centerline of the airplane (and fuselage) is on BL 0.0. The inside surface of the fuselage skin at the widest point in the fuselage is at BL 69.0. Buttock lines may be used as reference lines in the wings and empennage; then they are measured perpendicularly, without regard to dihedral angles, to the left or right of the centerline of the airplane. The extreme ends of the wing tips, when measured perpendicularly from BL 0.0, are at BL 720.0; the tips of the horizontal stabilizer are at BL 232.46.

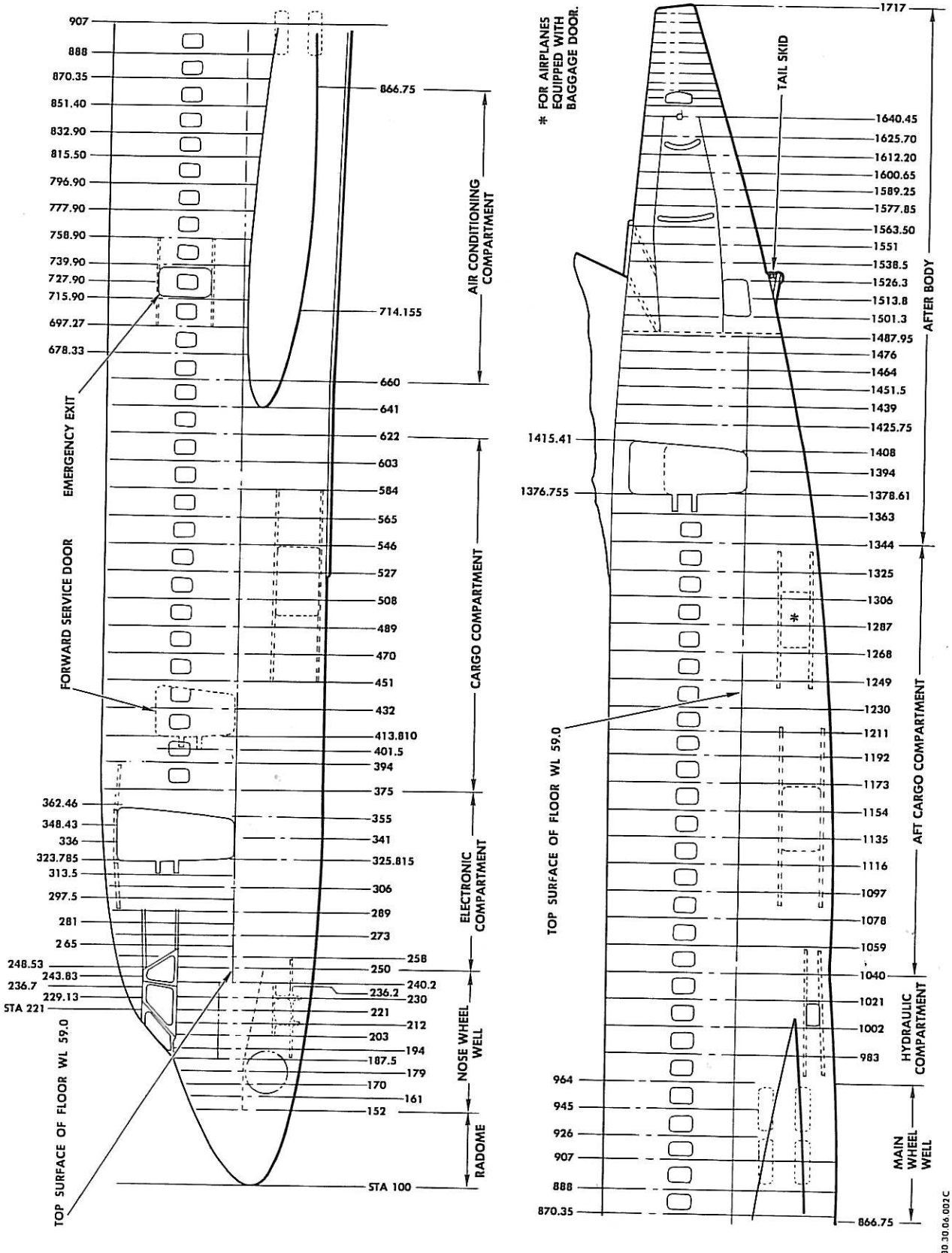
Engine pod or nacelle buttock lines are measured in inches laterally from vertical zero reference planes which are 100.0 inches inboard from each centerline of engine thrust. Thus, the centerline of engine thrust (and engine pod) at each nacelle is at BL 100.0. The inboard engine pod centerlines are at fuselage buttock line 266.0; the outboard engine pod centerlines are at fuselage buttock line 495.5.

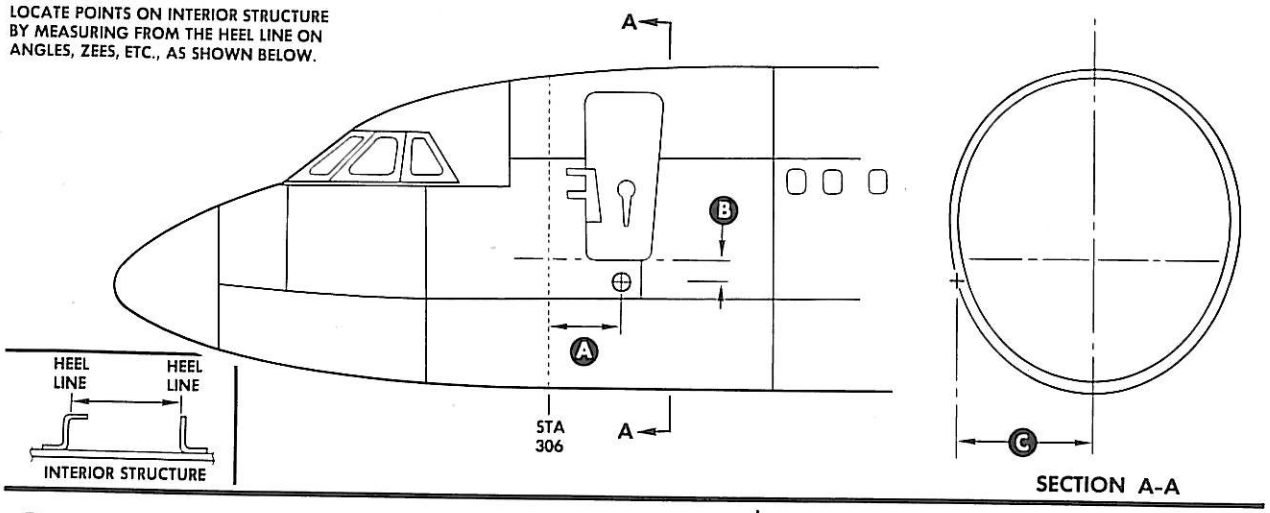
5. Locating Systems of Primary Airplane Components

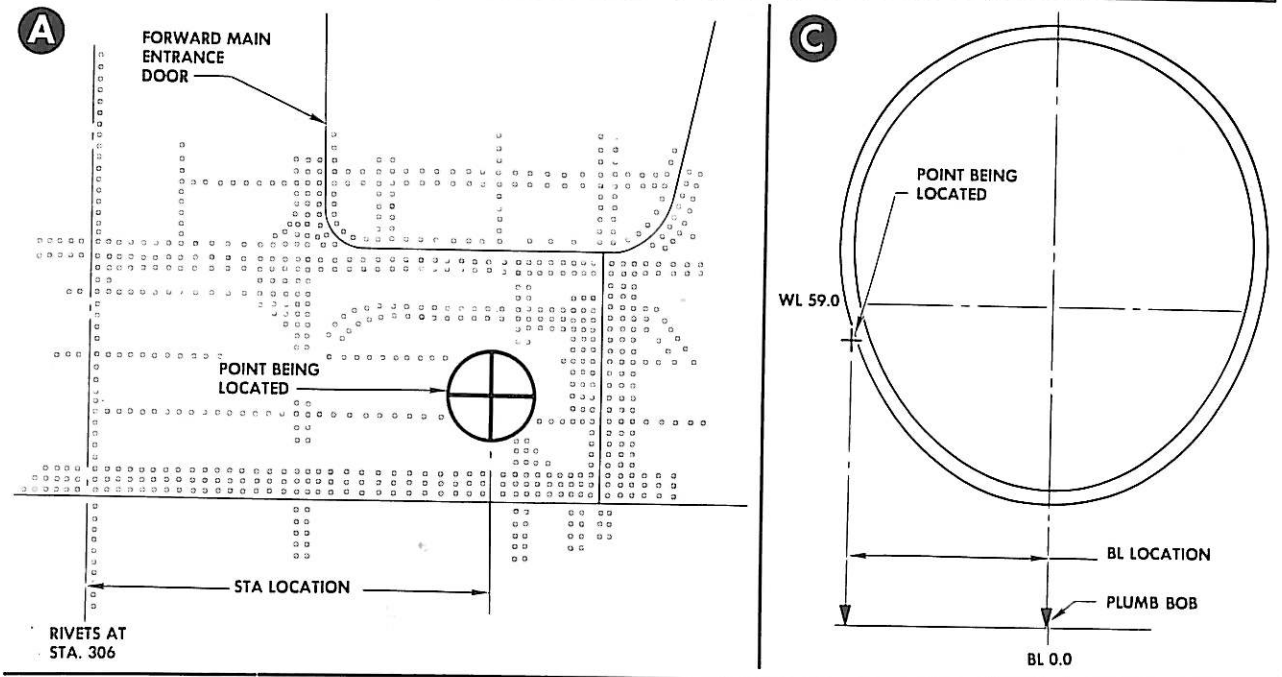
The individual locating systems for the fuselage, wings, anti-shock bodies, engine pods, and empennage are more completely explained in the following paragraphs.

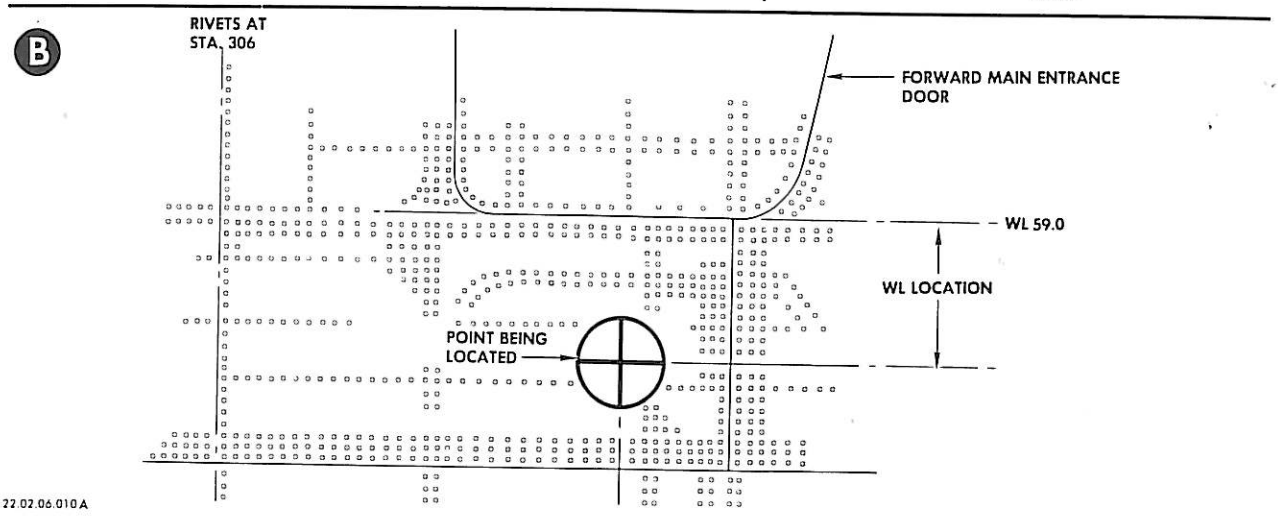
A. Fuselage.

Fuselage station lines (FS) provide vertical reference planes along the longitudinal or X axis of the airplane. These stations are measured in inches horizontally from a vertical zero reference plane established 100.0 inches forward of the nose of the airplane, thus eliminating negative fuselage station numbers. Fuselage stations on the airplane start from the nose at station 100.0 and continue to the fuselage tail cone at station 1717.0, and beyond that to the horizontal stabilizer trailing edge tips at station 1770.4. Figure 1 shows fuselage stations for frames, bulkheads, doors, compartments, and the like. Figure 2 shows an example for locating a specific point on the fuselage. Figure 3 shows cross sectional views of the fuselage and illustrates fuselage water lines and buttock lines.

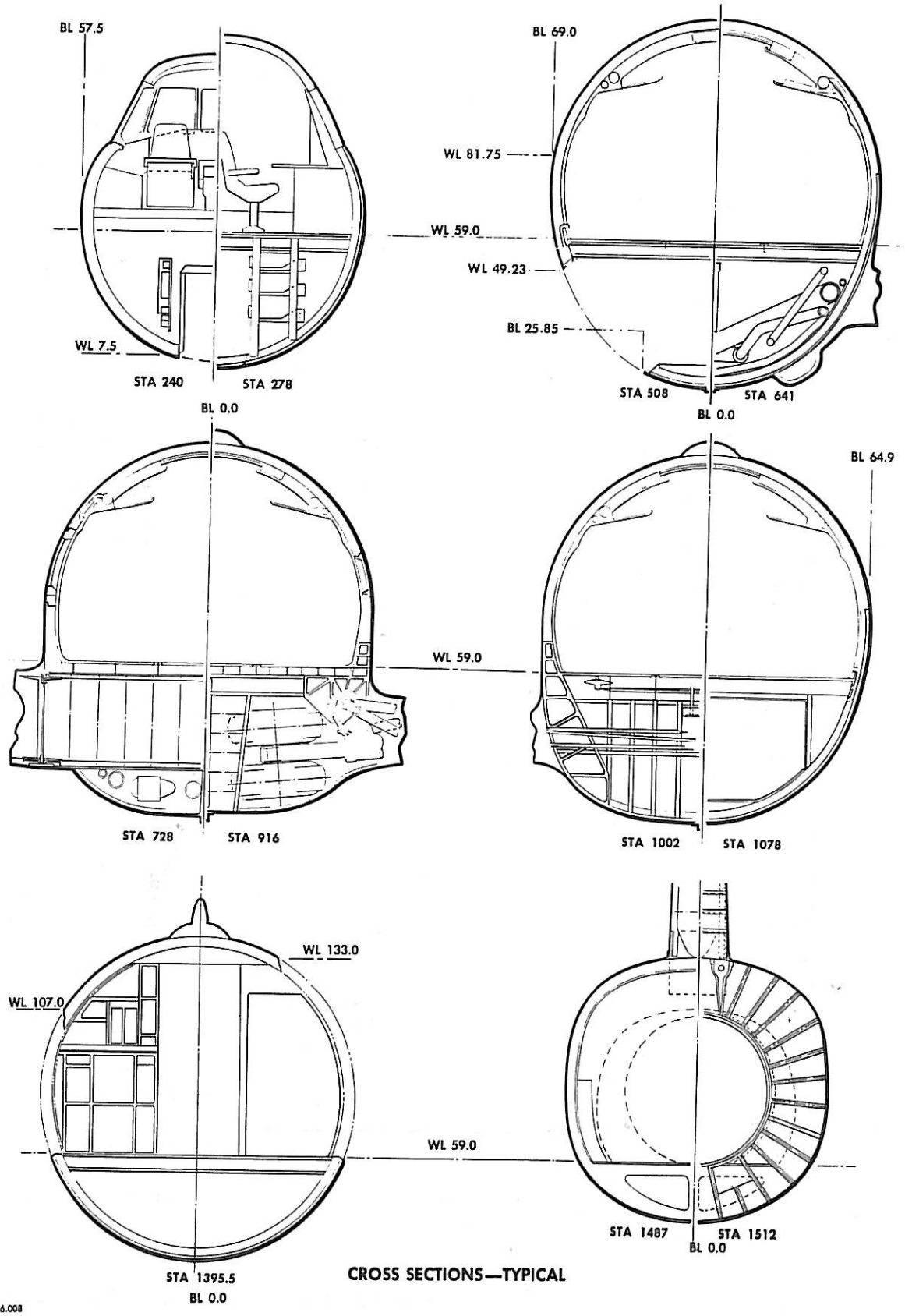

907
888
870.35
851.40
832.90
815.50
796.90
777.90
758.90
739.90
727.90
715.90
697.27
678.33
866.75
714.155
660
641
622
603
584
565
546
527
508
489
470
451
432
413.810
401.5
394
375
362.46
348.43
336
323.785
313.5
297.5
281
265
248.53
243.83
236.7
229.13
STA 221
355
341
325.815
306
289
273
258
250
240.2
236.2
230
221
212
203
194
187.5
179
170
161
152
STA 100
EMERGENCY EXIT
FORWARD SERVICE DOOR
TOP SURFACE OF FLOOR WL 59.0
AIR CONDITIONING COMPARTMENT
CARGO COMPARTMENT
ELECTRONIC COMPARTMENT
NOSE WHEEL WELL
RADOME
* FOR AIRPLANES EQUIPPED WITH BAGGAGE DOOR.
TAIL SKID
1717
1640.45
1625.70
1612.20
1600.65
1589.25
1577.85
1563.50
1551
1538.5
1526.3
1513.8
1501.3
1487.95
1476
1464
1451.5
1439
1425.75
1415.41
1408
1394
1376.755
1378.61
1363
1344
1325
1306
1287
1268
1249
1230
1211
1192
1173
1154
1135
1116
1097
1078
1059
1040
1021
1002
983
964
945
926
907
888
870.35
866.75
AFTER BODY
AFT CARGO COMPARTMENT
HYDRAULIC COMPARTMENT
MAIN WHEEL WELL
30 30.06.002C







Locating a Specific Point on Fuselage
Figure 2



CROSS SECTIONS—TYPICAL

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B. Wing.

Wing station lines (WS) are measured in inches from the centerline of the airplane to provide spanwise or lateral reference planes as shown on Figure 4. Because of the seven-degree wing dihedral angle, wing stations are measured along the wing manufacturing chord plane and are not the same as buttock lines. Figure 5 shows an example for locating a specific point on the wing.

Wing stations between WS 69.5 and WS 224.8, and those outboard of WS 688.0, are parallel to the centerline of the airplane. These stations are measured in inches outboard on the wing manufacturing chord plane along an axis perpendicular to, and originating at, the centerline of the airplane. WS 224.8 intersects the trailing edge at the break point of the wing and provides a useful reference.

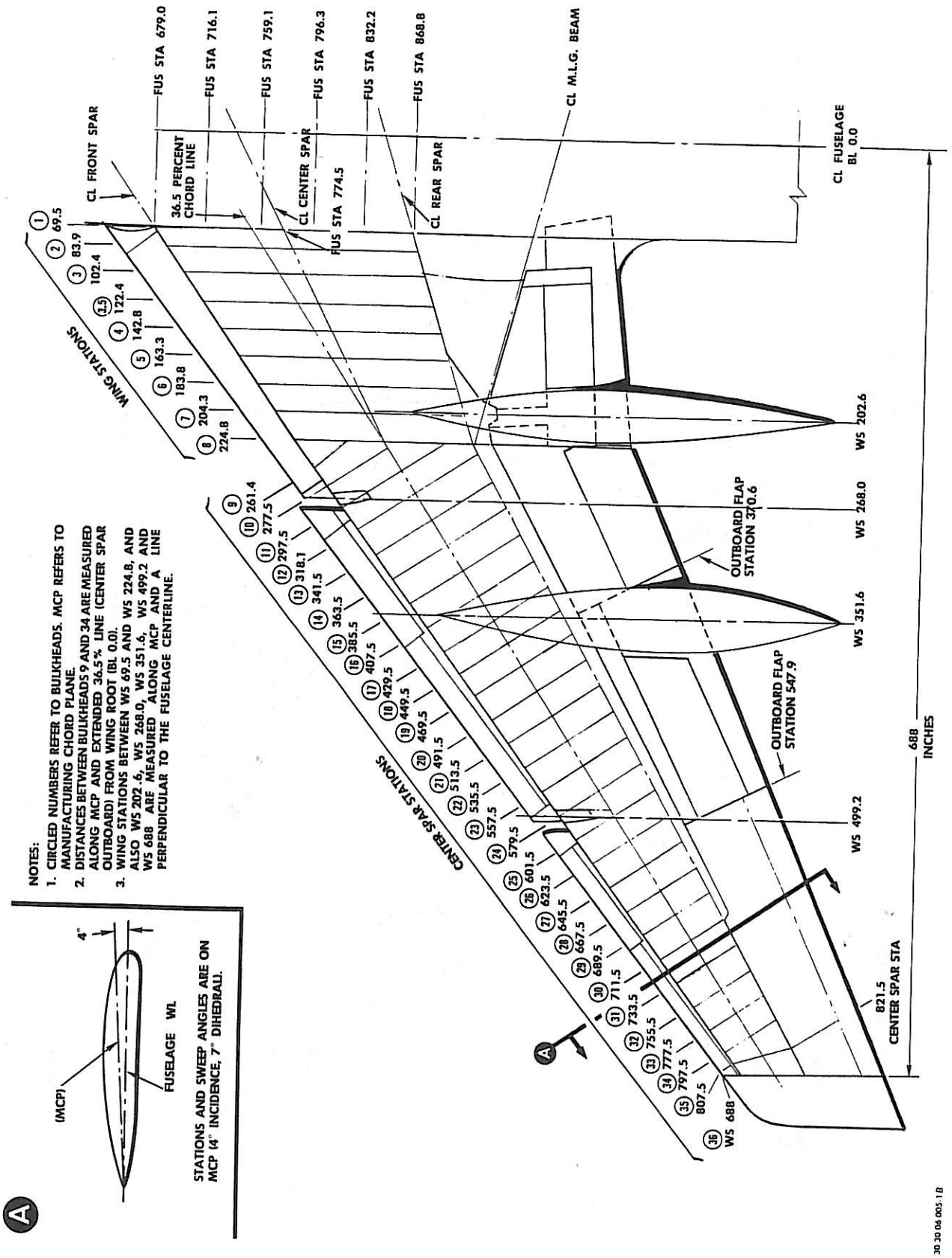
Center spar stations between wing bulkheads 9 and 35 are perpendicular to the wing center spar, which has a sweepback angle of approximately 34 degrees. These stations are measured on the wing manufacturing chord plane along the center spar and the 36.5 percent chord line extended to the centerline of the airplane. In addition to the wing and center spar stations, wing bulkheads and ribs are numbered from 1 through 36, starting at the first wing bulkhead outboard of the fuselage (WS 69.5). Any of these numbers may be cross referenced to a wing or a center spar station.

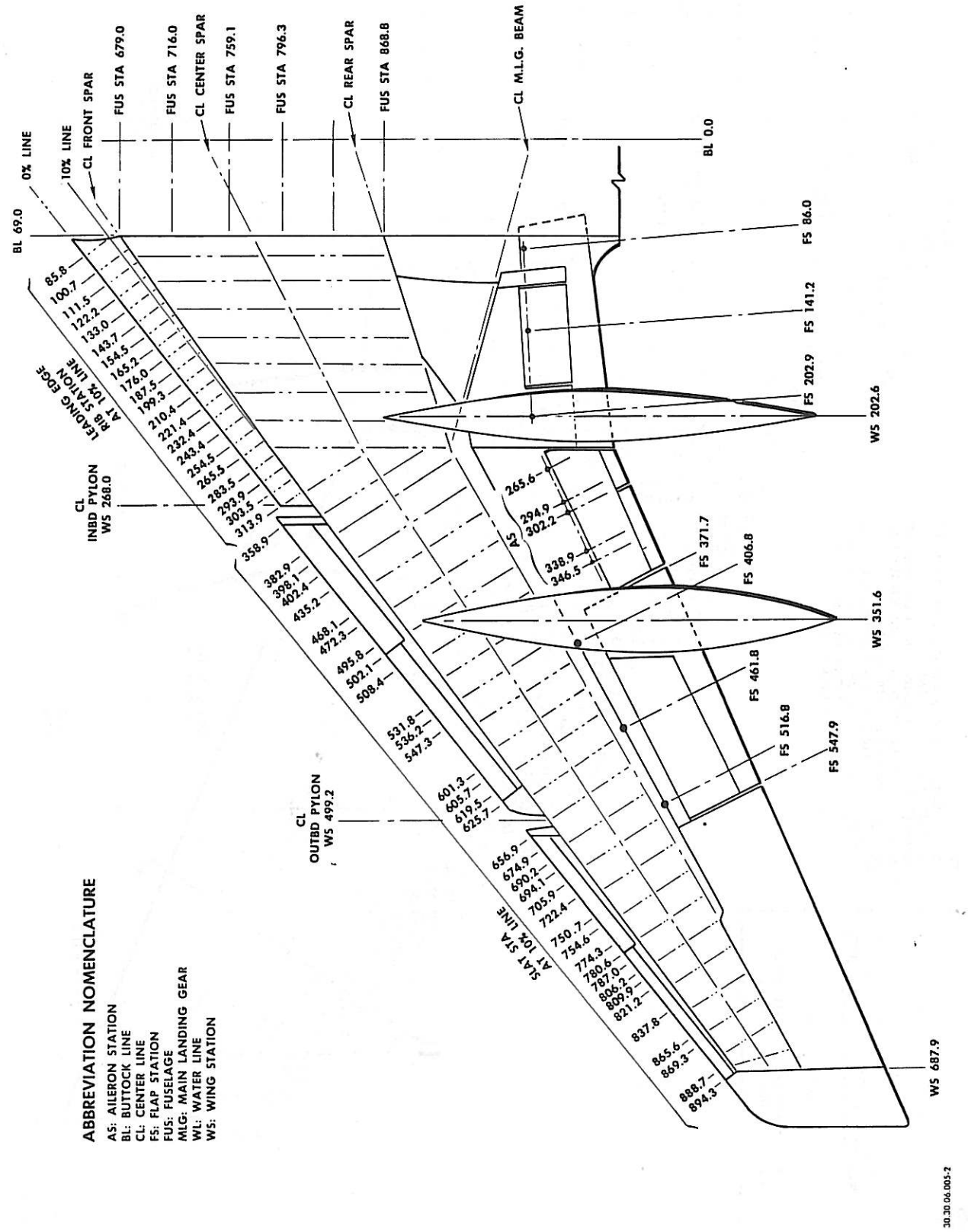
There are also separate numbering systems for the wing leading edges, wing flaps, spoilers, and ailerons. *Group I airplanes, in addition to the above, have separate numbering systems for the wing slats, and inboard leading edge flaps. *Group II airplanes have front spar stations only, which are from the outboard side of the inboard pylon.

C. Anti-Shock Bodies.

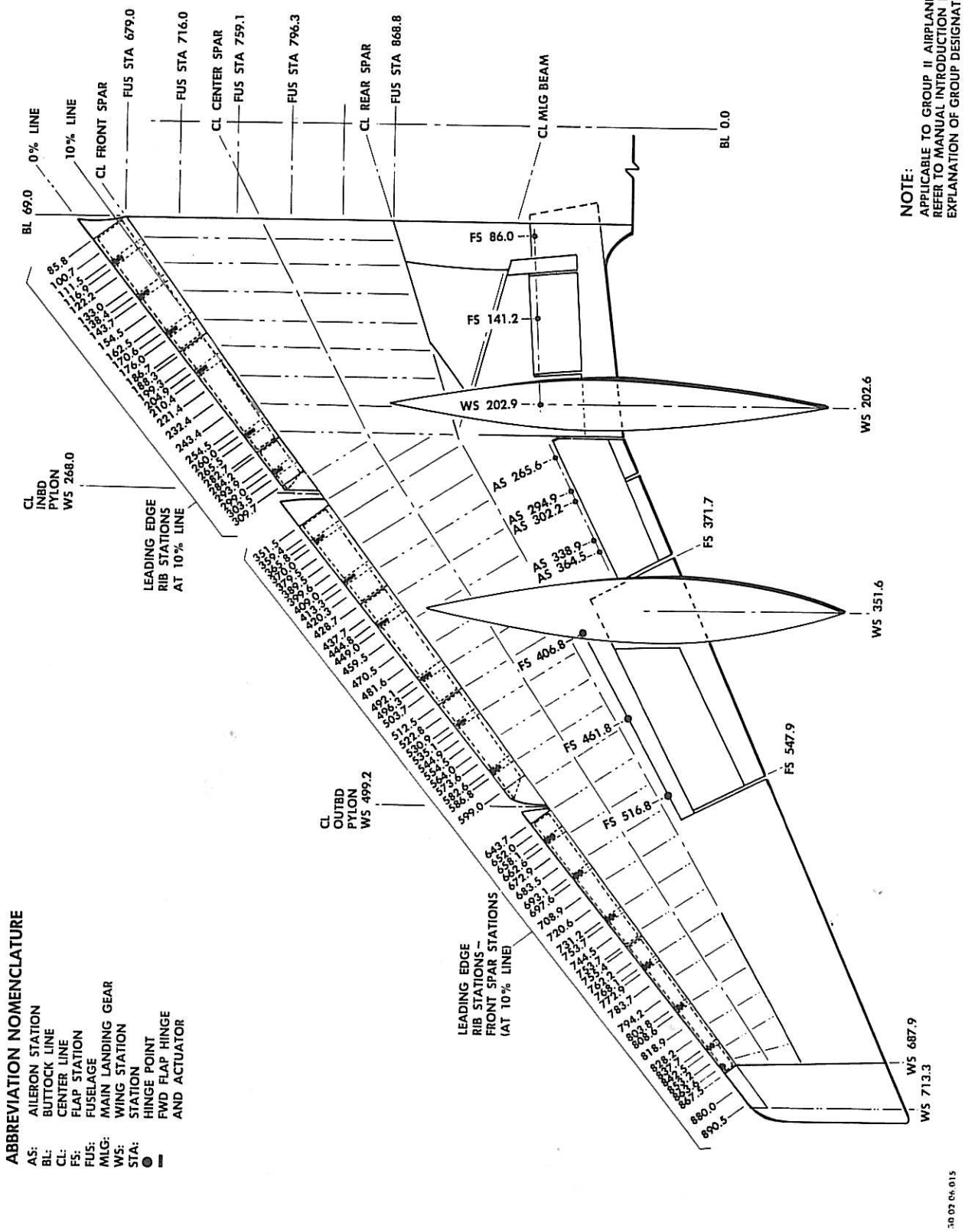
Anti-shock body stations are measured in inches aft from zero reference planes at the theoretical nose tips of the bodies. These zero reference planes are perpendicular to the wing manufacturing chord plane and hence are inclined four degrees from the vertical. The zero reference plane for the inboard anti-shock body is 129.258 inches on the manufacturing chord plane ahead of the wing leading edge at wing station 202.564. The zero reference plane for the outboard anti-shock body is 34.444 inches on the manufacturing chord plane ahead of the wing leading edge at wing station 351.634. No individual water line or buttock line systems are developed for the anti-shock bodies; vertical reference for manufacturing control is made to the wing manufacturing chord plane, and lateral reference is made to a plane perpendicular to the manufacturing chord plane and intersecting the theoretical nose and tail tips of the bodies. The station lines for both anti-shock bodies are shown on Figure 6.

*Refer to Manual INTRODUCTION for Explanation of Group Designations.


FUS STA 679.0
FUS STA 716.1
FUS STA 759.1
FUS STA 796.3
FUS STA 832.2
FUS STA 868.8
CL M.L.G. BEAM
CL FUSELAGE BL 0.0
CL FRONT SPAR
36.5 PERCENT CHORD LINE
CL CENTER SPAR
FUS STA 774.5
CL REAR SPAR
WING STATIONS
1 69.5
2 83.9
3 102.4
3.5 122.4
4 142.8
5 163.3
6 183.8
7 204.3
8 224.8
9 261.4
10 277.5
11 297.5
12 318.1
13 341.5
14 363.5
15 385.5
16 407.5
17 429.5
18 449.5
19 469.5
20 491.5
21 513.5
22 535.5
23 557.5
24 579.5
25 601.5
26 623.5
27 645.5
28 667.5
29 689.5
30 711.5
31 733.5
32 755.5
33 777.5
34 797.5
35 807.5
36 WS 688
CENTER SPAR STATIONS
WS 202.6
WS 268.0
OUTBOARD FLAP STATION 370.6
WS 351.6
OUTBOARD FLAP STATION 547.9
WS 499.2
688 INCHES
821.5 CENTER SPAR STA
NOTES:
1. CIRCLED NUMBERS REFER TO BULKHEADS. MCP REFERS TO MANUFACTURING CHORD PLANE.
2. DISTANCES BETWEEN BULKHEADS 9 AND 34 ARE MEASURED ALONG MCP AND EXTENDED 36.5% LINE (CENTER SPAR OUTBOARD) FROM WING ROOT (BL 0.0).
3. WING STATIONS BETWEEN WS 69.5 AND WS 224.8, AND ALSO WS 202.6, WS 268.0, WS 351.6, WS 499.2 AND WS 688 ARE MEASURED ALONG MCP AND A LINE PERPENDICULAR TO THE FUSELAGE CENTERLINE.
A
4°
(MCP)
FUSELAGE WL
STATIONS AND SWEEP ANGLES ARE ON MCP (4° INCIDENCE, 7° DIHEDRAL).
30 30 06 005-1B



Wing Station Diagram
Applicable to Group I Airplanes
Figure 4 (Sheet 2 of 3)



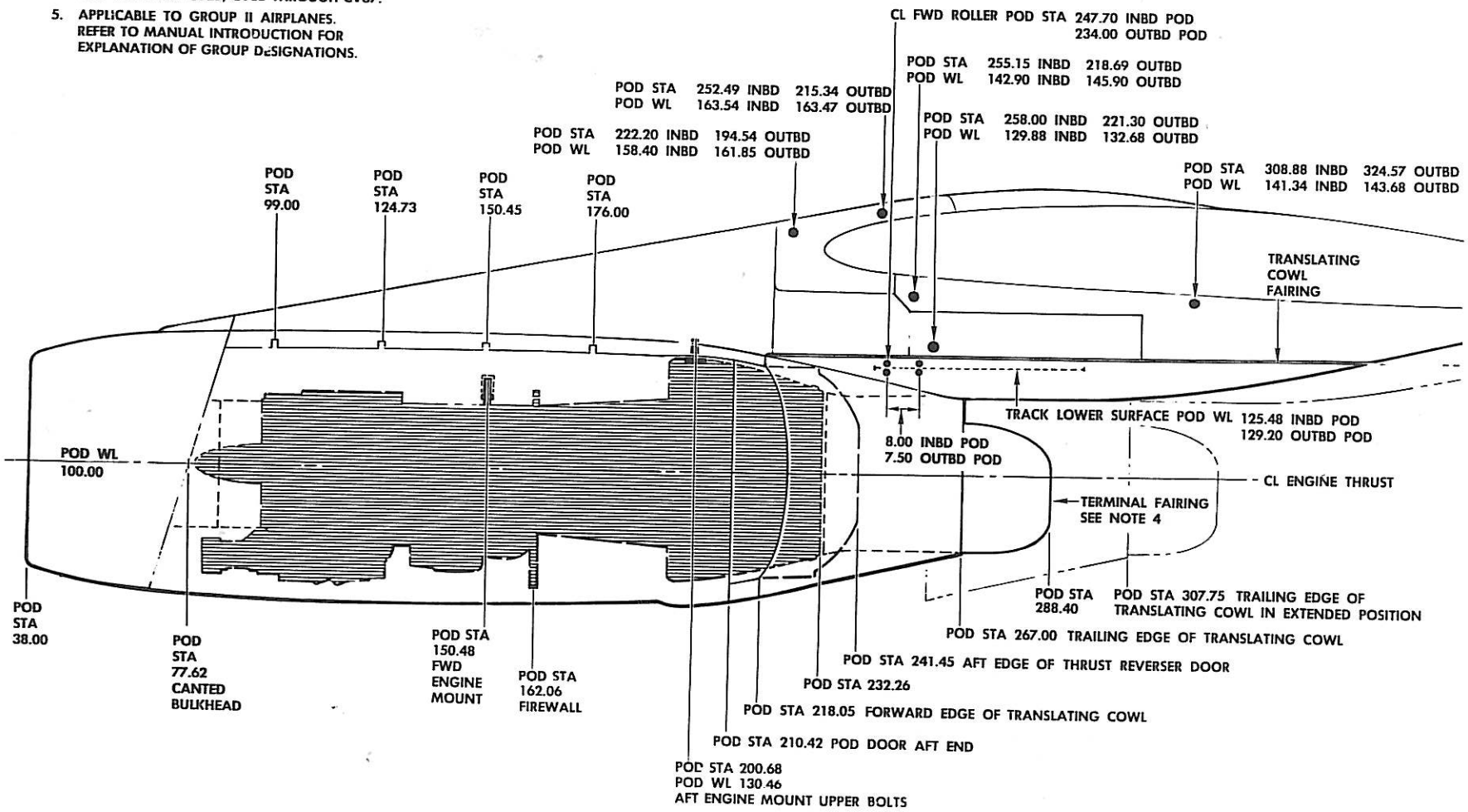
NOTE:
APPLICABLE TO GROUP II AIRPLANES.
REFER TO MANUAL INTRODUCTION FOR EXPLANATION OF GROUP DESIGNATIONS.

30 07 04 015

Wing Station Diagram
Figure 4 (Sheet 3 of 3)

NOTE:

1. INBOARD ENGINE POD AND PYLON SHOWN, OUTBOARD ENGINE POD AND PYLON SIMILAR.
2. POD STATIONS 99.00, 124.73, 150.45, 176.00 ARE POD DOOR HINGE CENTER LINE REFERENCES.
3. ● INDICATES PYLON-TO-WING ATTACH POINTS, STATION AND WATER LINE REFERENCES ARE GIVEN FOR INBOARD AND OUTBOARD PYLONS.
4. TERMINAL FAIRING APPLICABLE TO AIRPLANES: CV1 THROUGH CV25, CV35 THROUGH CV37.
5. APPLICABLE TO GROUP II AIRPLANES. REFER TO MANUAL INTRODUCTION FOR EXPLANATION OF GROUP DESIGNATIONS.

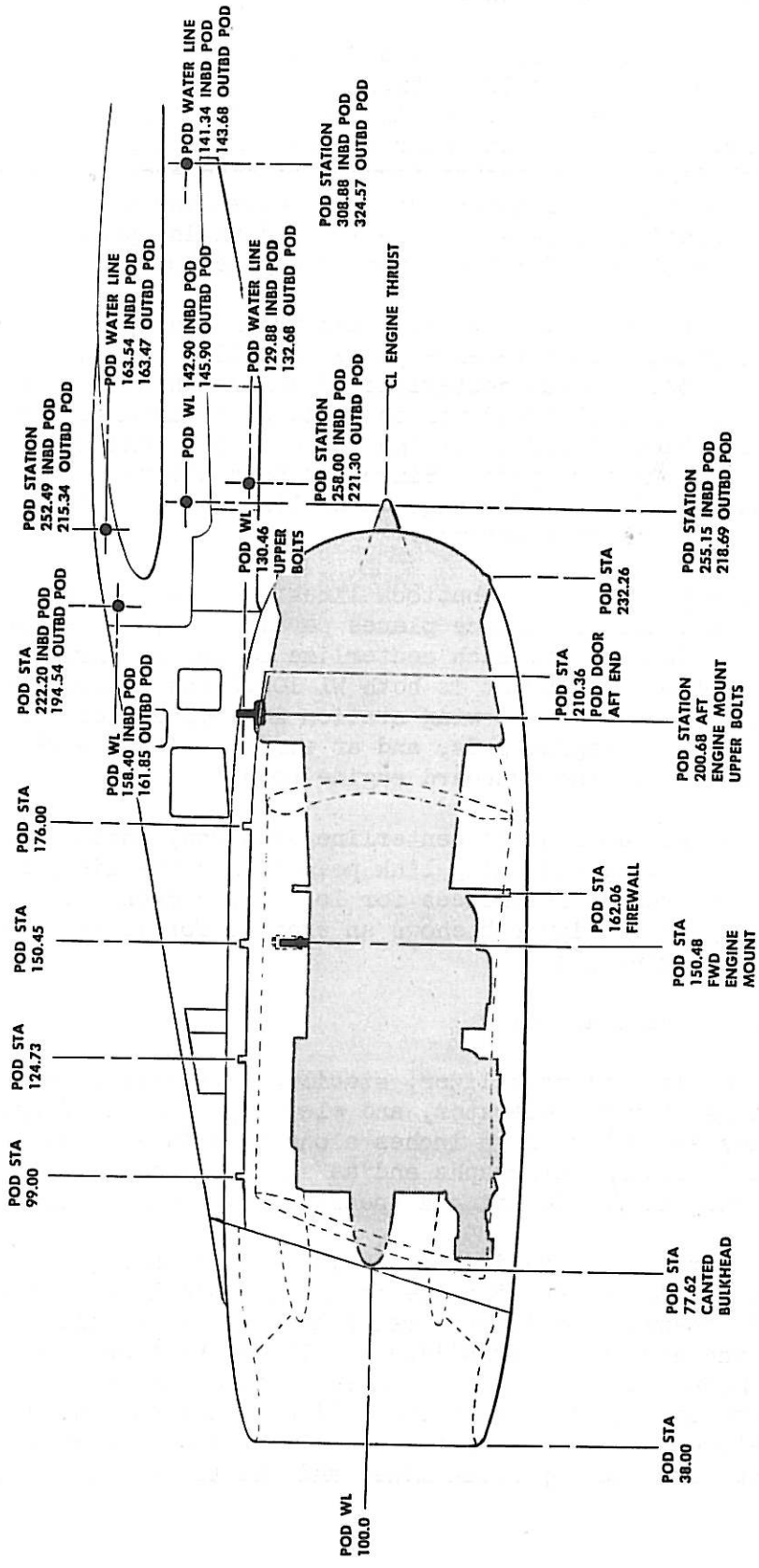


30 32 06 014

Engine Pod and Pylon Station Diagram
Figure 7 (Sheet 2 of 2)

NOTE

1. INBOARD ENGINE POD AND PYLON OUTLINE SHOWN, OUTBOARD ENGINE POD AND PYLON OUTLINE SIMILAR.
2. POD STATIONS 99.00, 124.73, 150.45, 176.00 ARE ENGINE POD DOOR HINGE CENTER LINE REFERENCES.
3. ● INDICATES PYLON TO WING ATTACH POINTS.



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Engine Pod and Pylon Station Diagram
Applicable to Group I Airplanes
Figure 7 (Sheet 1 of 2)

D. Engine Pods and Pylons.

The station numbering system for the engine pods (nacelles) and pylons is independent of other station numbering systems. Engine pod and pylon stations are measured in inches aft from nearly vertical zero reference planes perpendicular to each centerline of engine thrust and established 38.00 inches forward of each engine intake duct cowling. Pod station 38.00 intersects the centerline of engine thrust at fuselage station 605.444 for the inboard engine pods, and at fuselage station 820.619 for the outboard engine pods.

Engine pod and pylon water lines are measured in inches up from nearly horizontal zero reference planes parallel to, and established 100.0 inches below, each centerline of engine thrust. For manufacturing control, pod WL 100.0 was established to intersect pod station 38.00 at fuselage WL 6.716 for the inboard pods, and at fuselage WL 17.692 for the outboard pods. Since the pods are depressed by fuel and other wing loads, these fuselage water lines are of little value for engine pod maintenance reference.

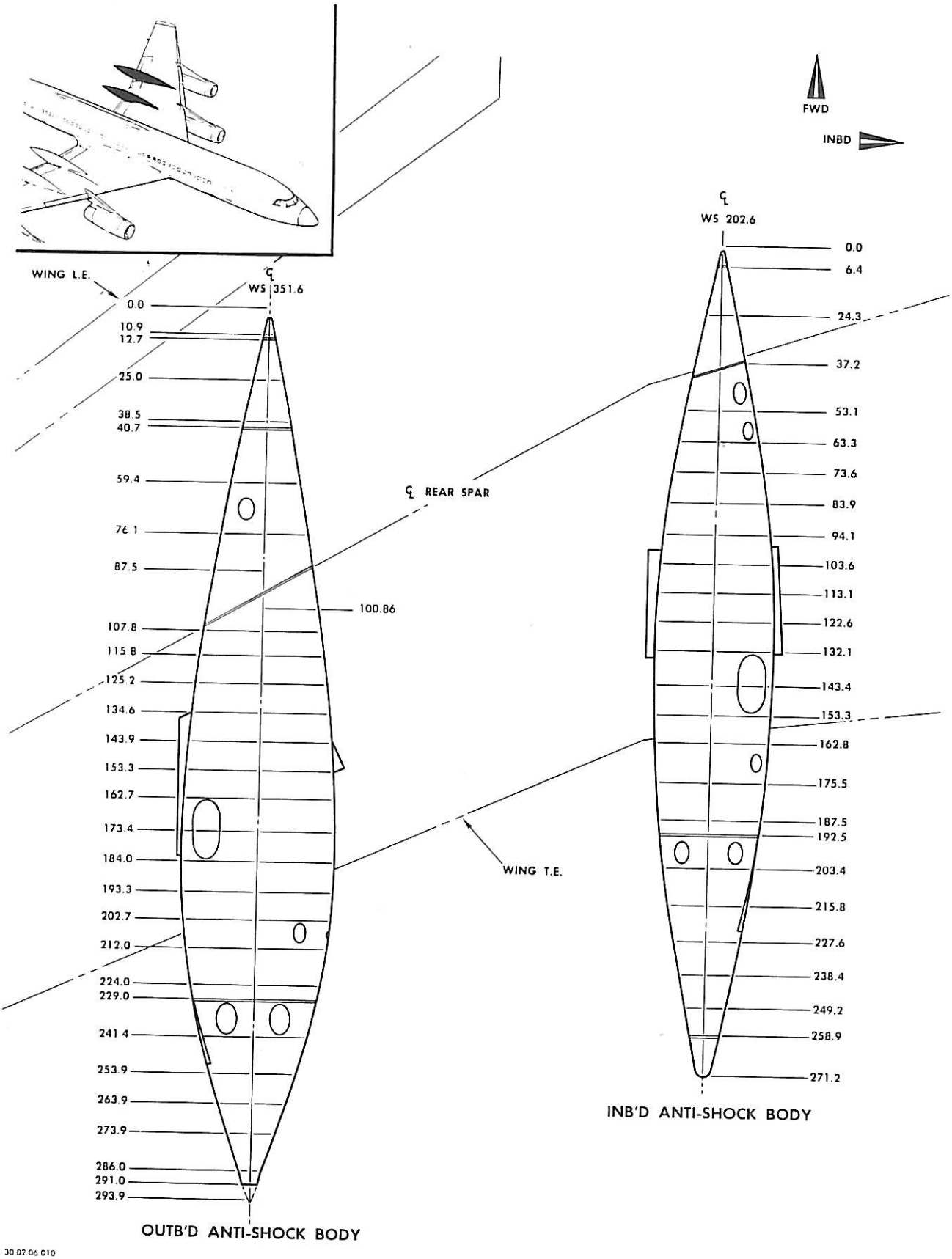
Engine pod and pylon buttock lines are measured in inches outboard from vertical zero reference planes parallel to, and established 100.0 inches inboard of, each centerline of engine thrust. Thus the centerline of engine thrust is both WL 100.0 and BL 100.0 for each engine pod. BL 100.0 is at wing station 267.988 and at fuselage BL 266.0 for the inboard engine pods, and at wing station 499.221 and at fuselage BL 495.5 for the outboard engine pods.

Engine pod door hinge centerline stations, engine mount centerlines, pylon to wing attaching link points, and the like, as shown on Figure 7 may be used as references for locating components on the engine pods and pylons. Figure 8 shows an example for locating a specific point on an engine pod.

E. Horizontal Stabilizer.

The horizontal stabilizer, stabilizer leading edge rib, stabilizer interspar ribs, elevator, and elevator trim and flight tab station lines are measured in inches along individual axes as described in the following paragraphs and as shown on Figure 9. Figure 10 shows an example for locating a specific point on the horizontal stabilizer.

The horizontal stabilizer stations shown on Figure 9 are measured along the stabilizer chord plane from the centerline of the airplane to provide spanwise or lateral reference planes parallel to the centerline of the horizontal stabilizers. Since the stabilizers have a 7 degree 30 minute dihedral angle, these stations are not the numerical equivalent of the airplane buttock lines. The only significant structural features of the horizontal stabilizer that are on stabilizer station lines are the tip break lines and the tip extremity line.



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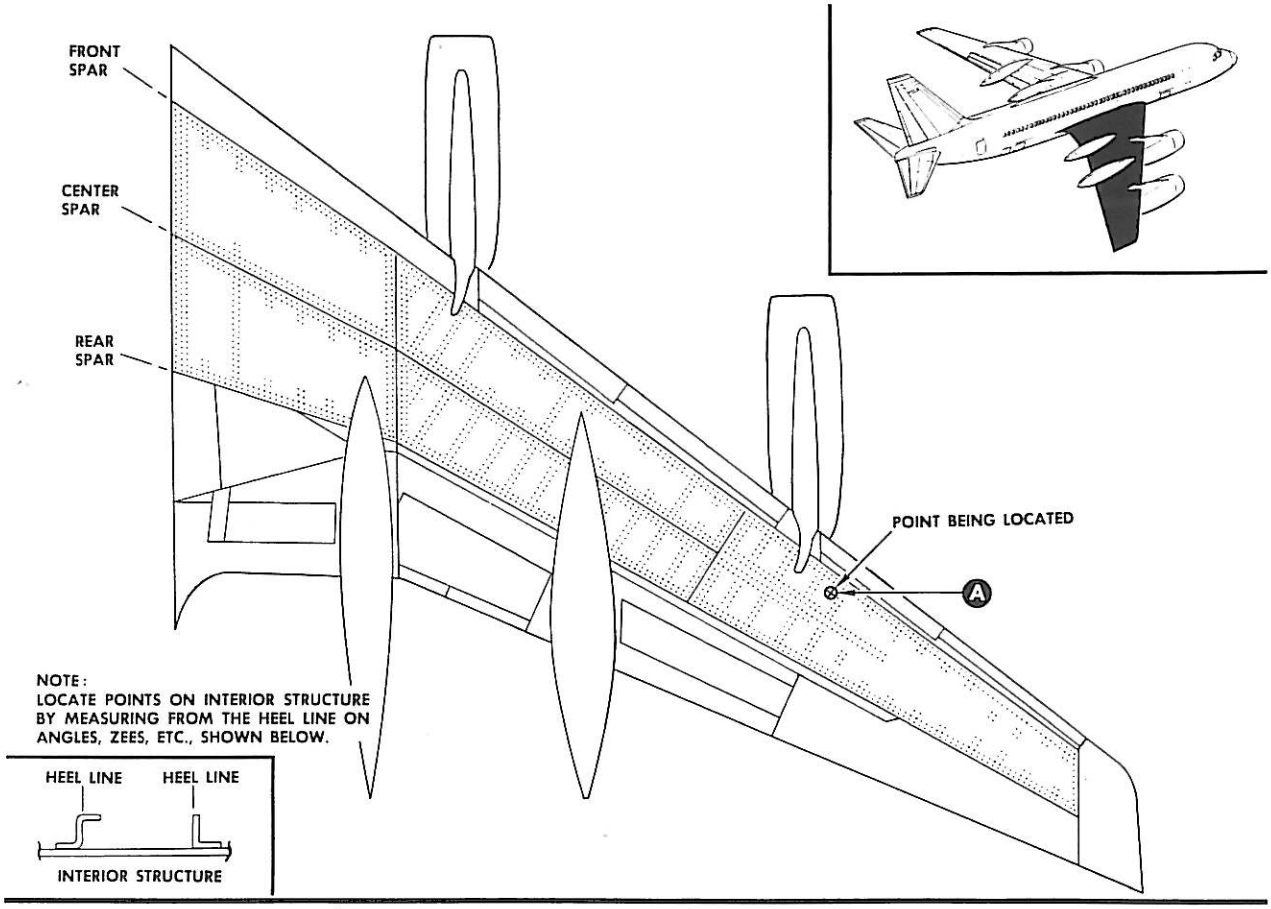
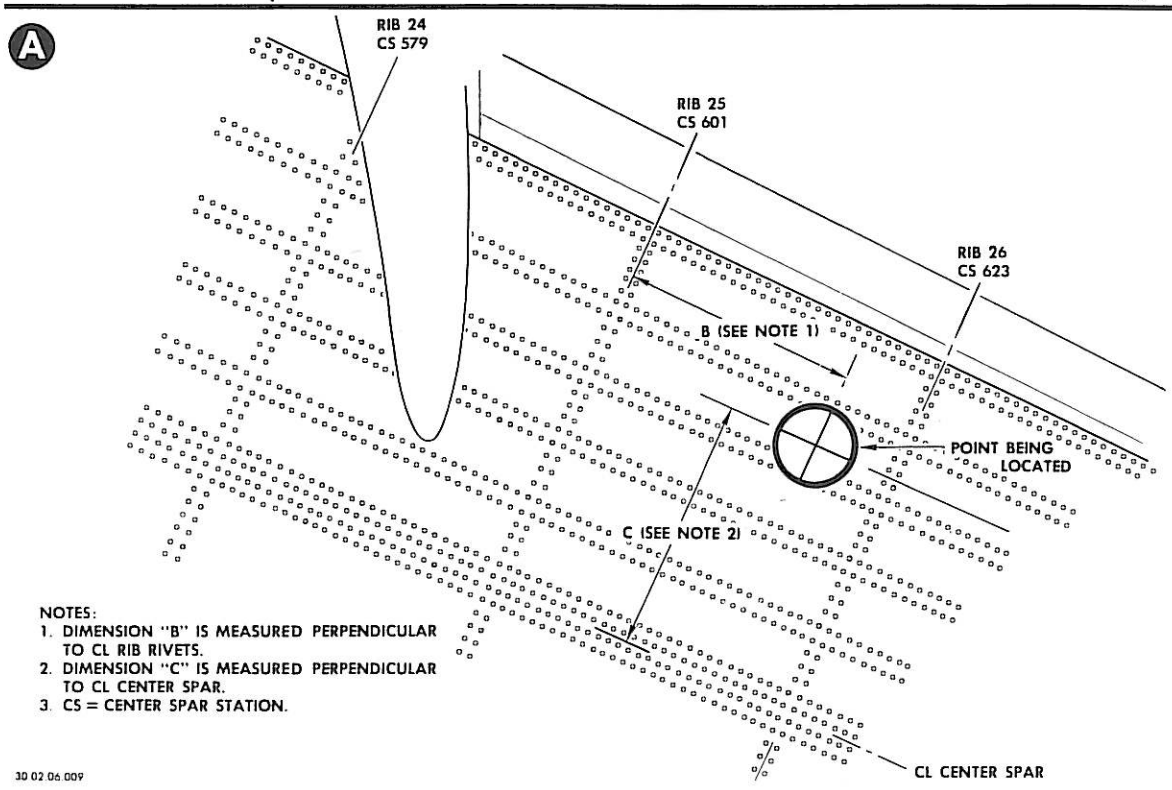
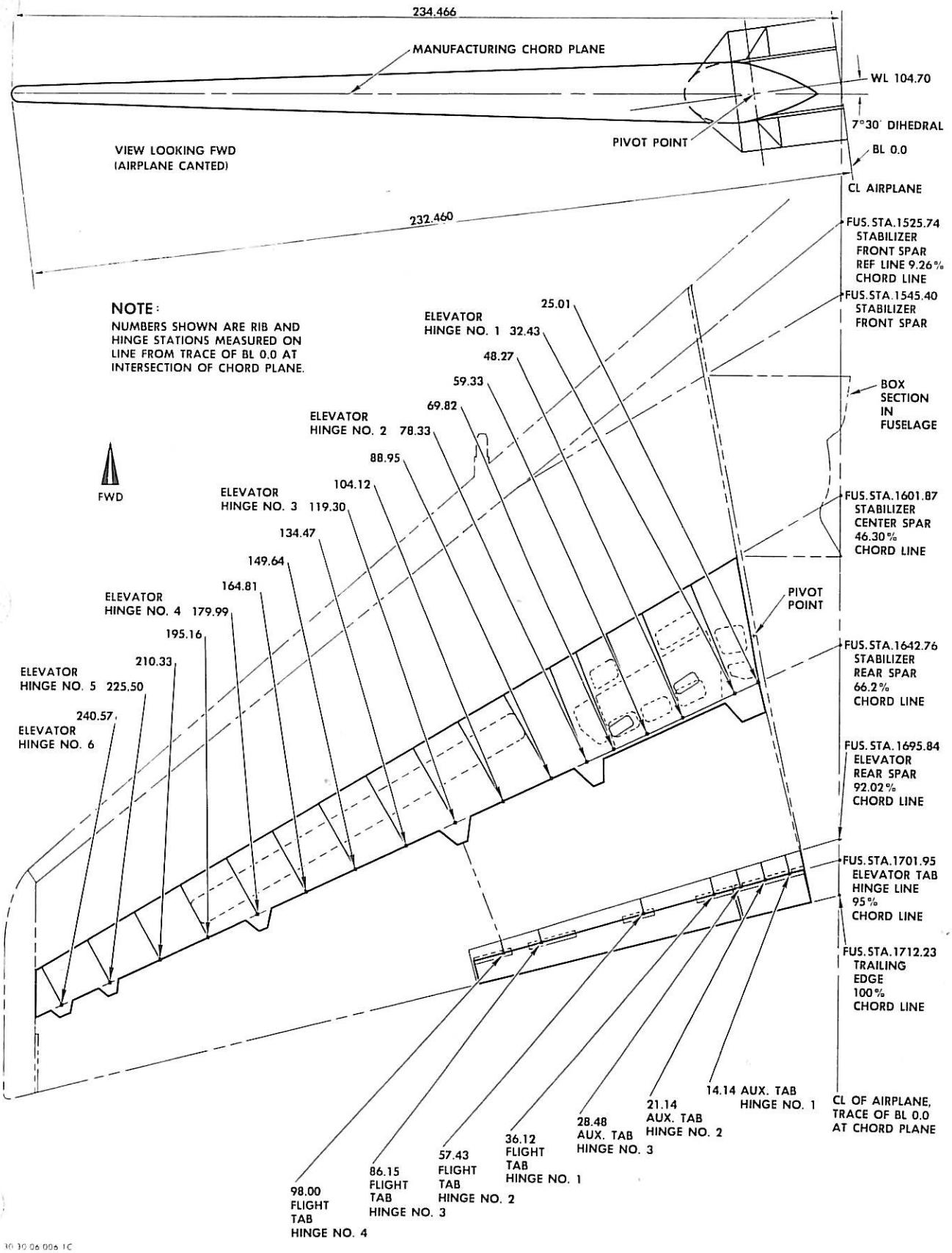
Anti-Shock Bodies Station Diagrams
Figure 6


FRONT SPAR
CENTER SPAR
REAR SPAR
POINT BEING LOCATED
A
NOTE:
LOCATE POINTS ON INTERIOR STRUCTURE BY MEASURING FROM THE HEEL LINE ON ANGLES, ZEES, ETC., SHOWN BELOW.
HEEL LINE
HEEL LINE
INTERIOR STRUCTURE


A
RIB 24 CS 579
RIB 25 CS 601
RIB 26 CS 623
B (SEE NOTE 1)
POINT BEING LOCATED
C (SEE NOTE 2)
CL CENTER SPAR
NOTES:
1. DIMENSION "B" IS MEASURED PERPENDICULAR TO CL RIB RIVETS.
2. DIMENSION "C" IS MEASURED PERPENDICULAR TO CL CENTER SPAR.
3. CS = CENTER SPAR STATION.
30 02 06.009



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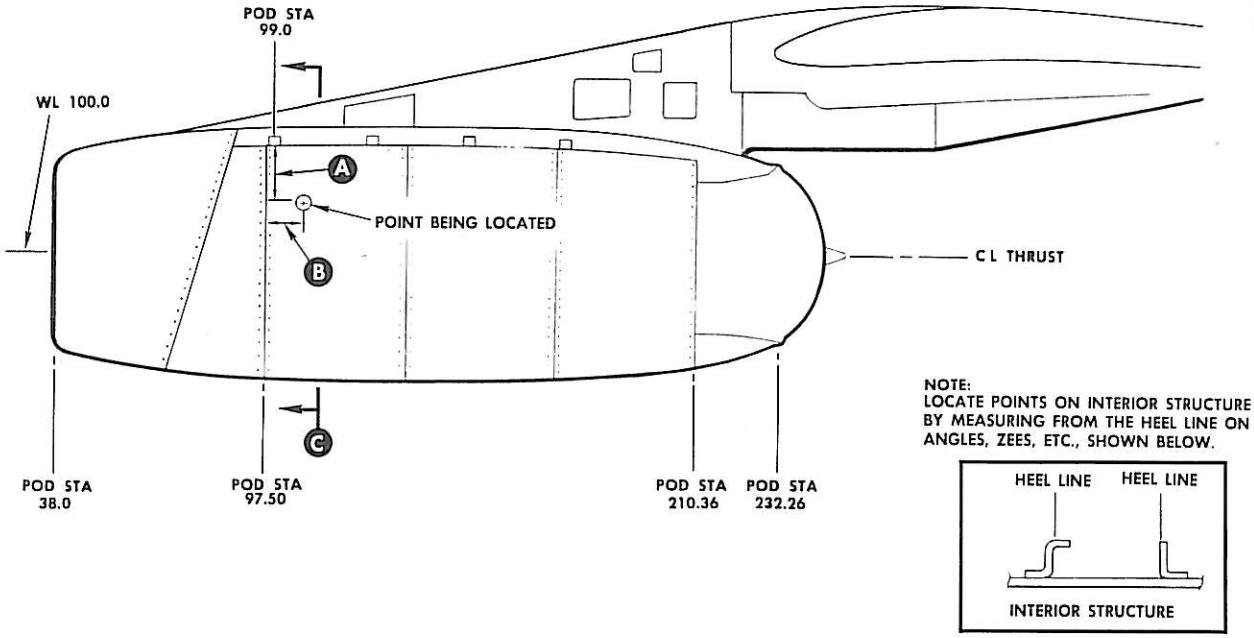
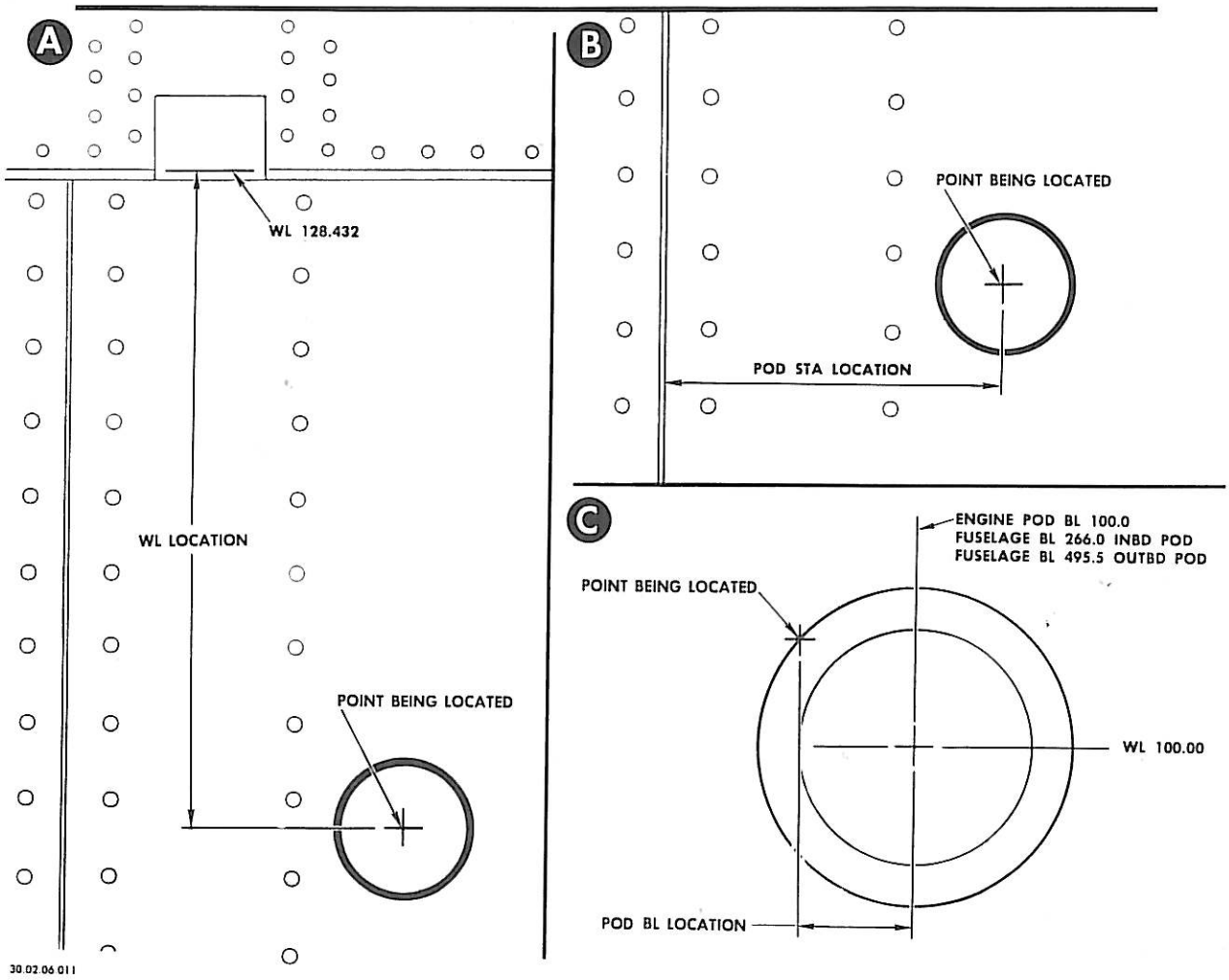
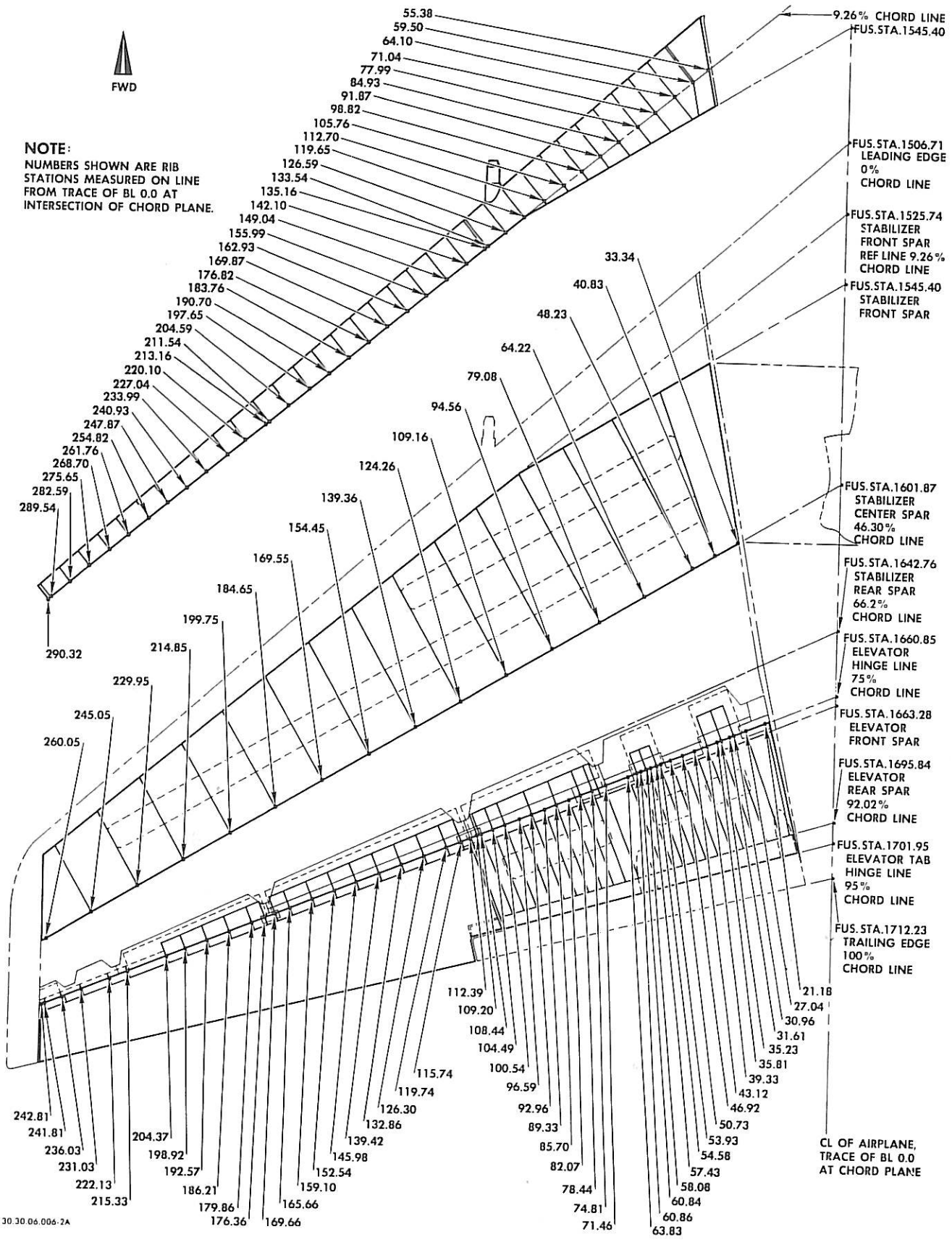
Horizontal Stabilizer Station Diagram
Figure 9 (Sheet 1 of 2)



NOTE:
LOCATE POINTS ON INTERIOR STRUCTURE BY MEASURING FROM THE HEEL LINE ON ANGLES, ZEES, ETC., SHOWN BELOW.



Locating a Specific Point on Engine Pod and Pylon
Figure 8



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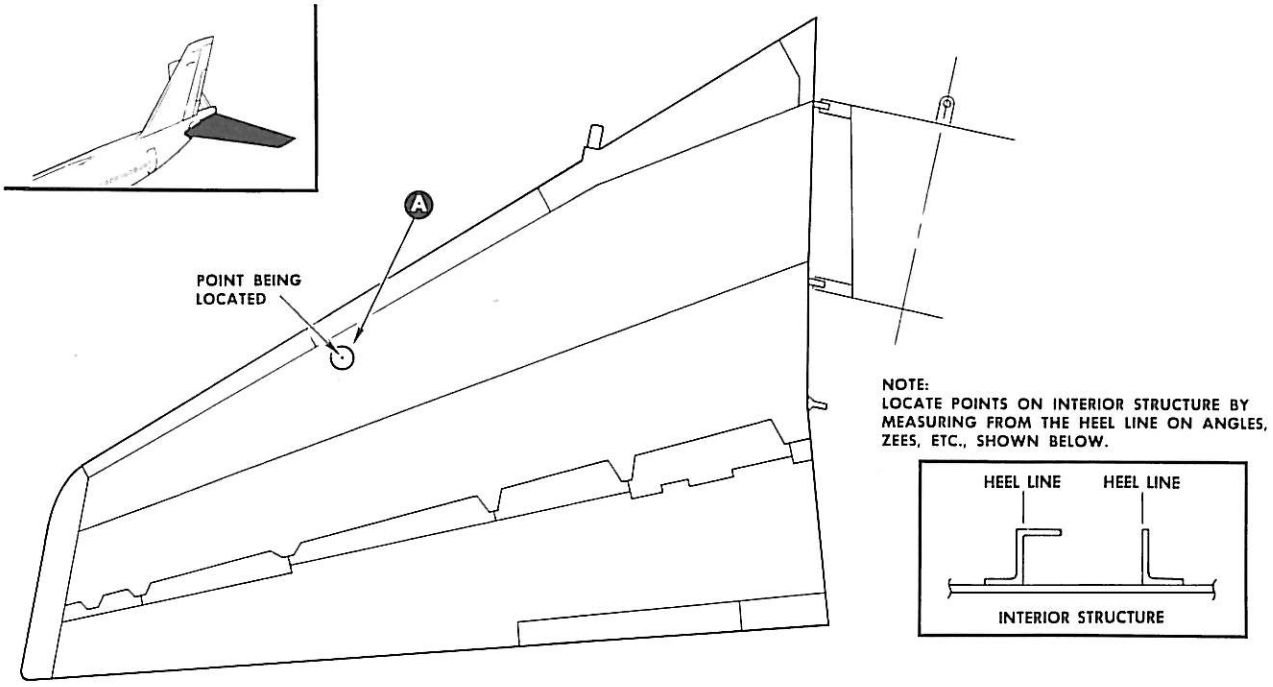
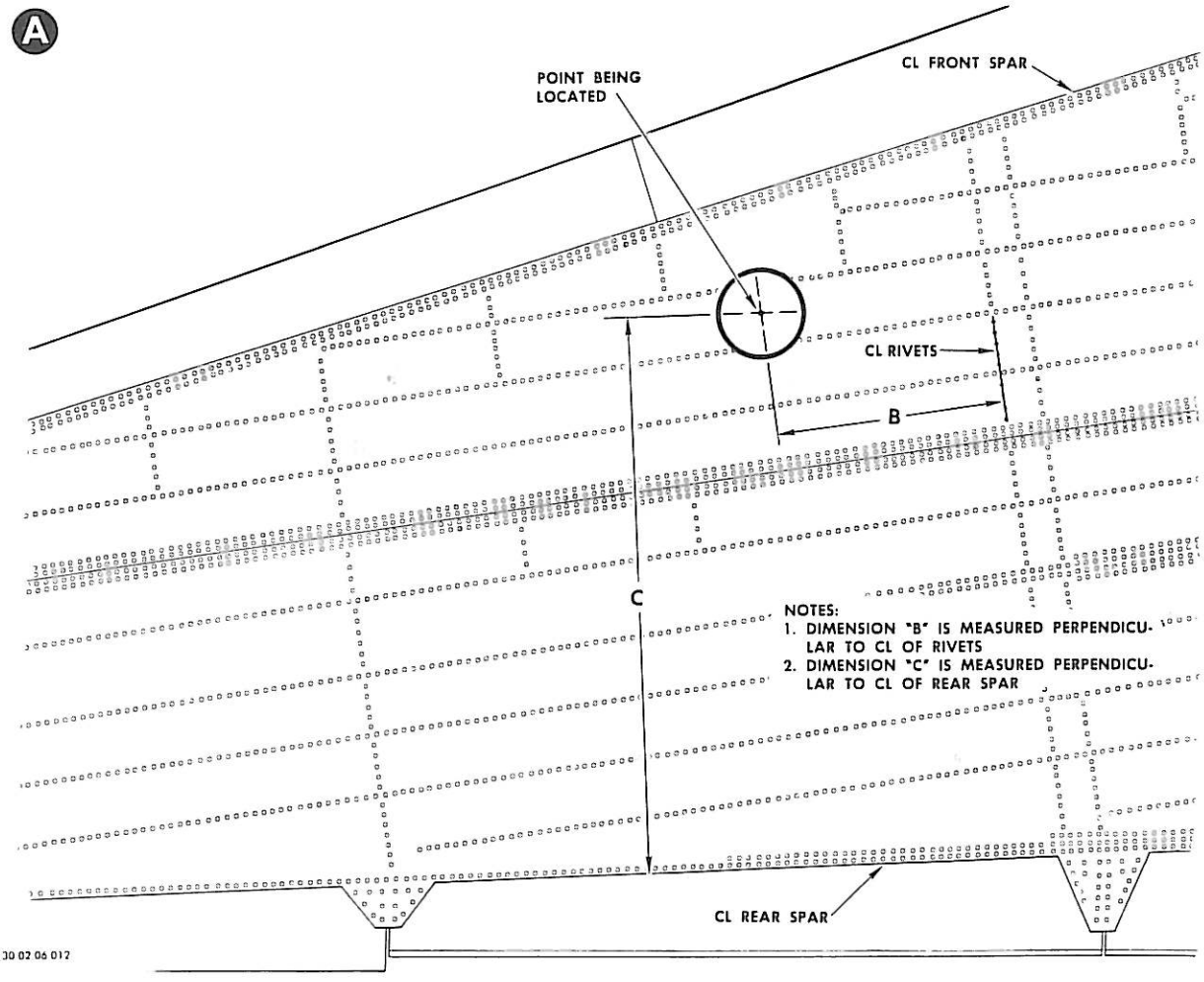
Horizontal Stabilizer Station Diagram
Figure 9 (Sheet 2 of 2)





Locating a Specific Point on Horizontal Stabilizer
Figure 10

Horizontal stabilizer leading edge rib stations are measured along the 9.26 percent chord line from a zero reference point at the intersection of the 9.26 percent chord line and the centerline of the airplane at fuselage station 1525.74. These stations are perpendicular to the 9.26 percent chord line, which is the front spar centerline outboard of leading edge station 118.92.

Horizontal stabilizer stations for the ribs between the front and center spars are measured along the centerline of the center spar from a zero reference point at the intersection of the centerline of the center spar and the centerline of the airplane at fuselage station 1601.87. Excepting for rib number one, these ribs are perpendicular to the center spar centerline, which is on the 46.302 percent chord line.

Horizontal stabilizer stations for the ribs between the center and rear spars are measured along the centerline of the rear spar from a zero reference point at the intersection of the centerline of the rear spar and the centerline of the airplane at fuselage station 1642.76. Excepting for the first five ribs, these ribs are perpendicular to the rear spar centerline, which is on the 66.2 percent chord line.

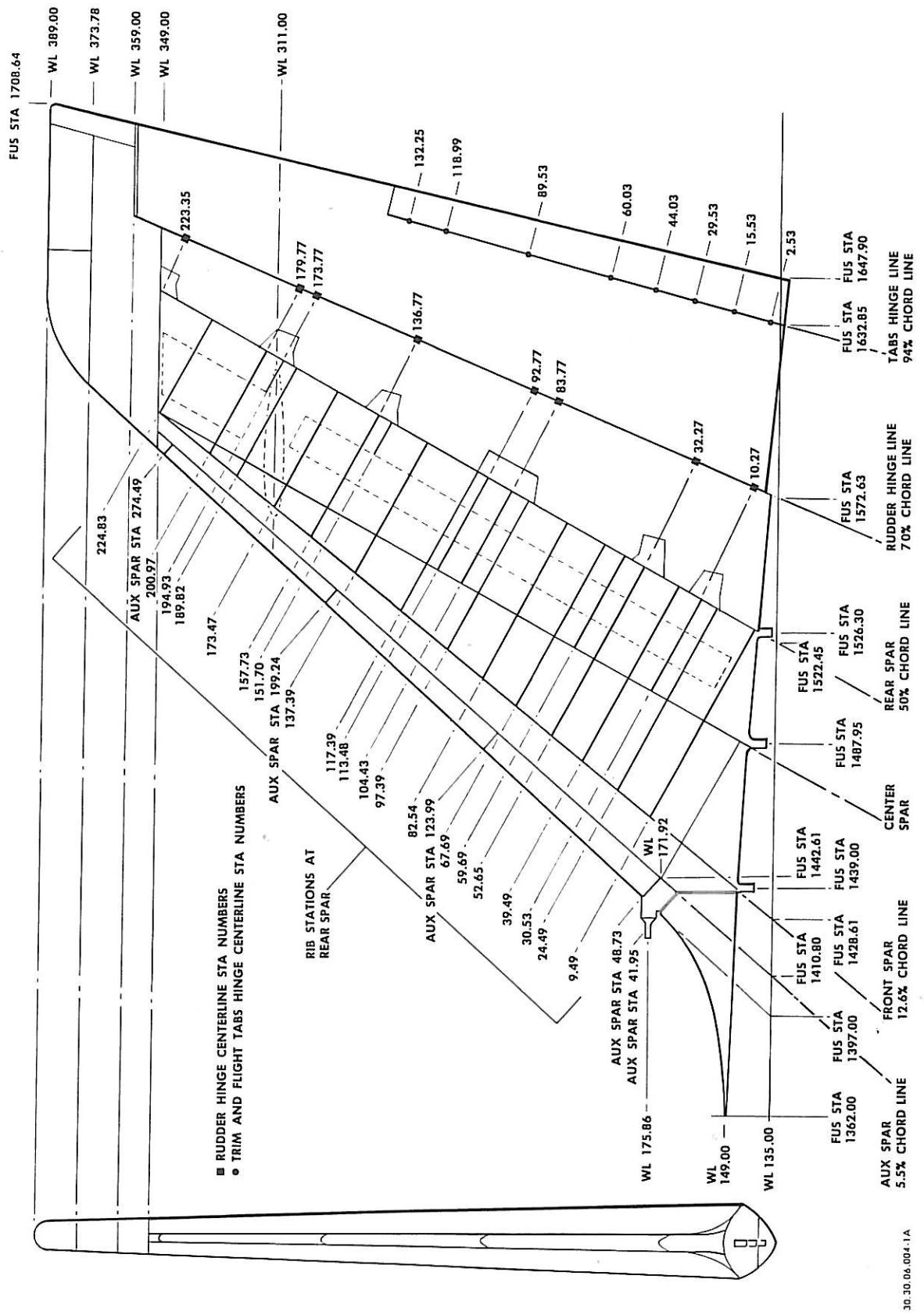
Elevator stations are measured along the elevator hinge line from a zero reference point at the intersection of the elevator hinge line and the centerline of the airplane at fuselage station 1660.85. These stations are perpendicular to the elevator hinge line, which is on the 75% chord line.

Elevator trim and flight tab stations are measured along the tabs hinge line from a zero reference point at the intersection of the tabs hinge line and the centerline of the airplane at fuselage station 1701.95. These stations are perpendicular to the tabs hinge line, which is on the 95% chord line.

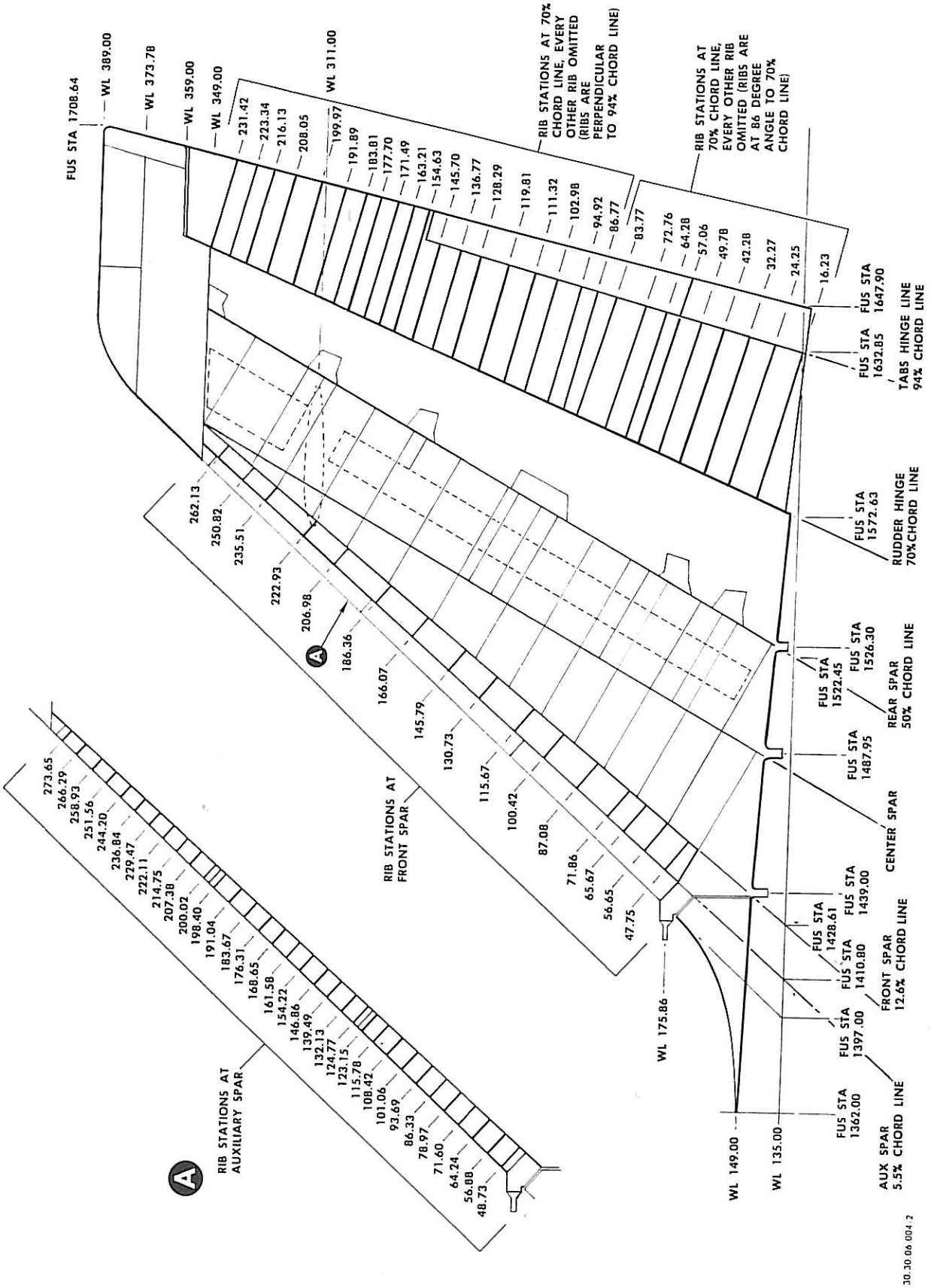
F. Vertical Stabilizer.

The vertical stabilizer (fin), stabilizer leading edge rib, interspar ribs, rudder, and rudder trim and flight tab station lines are measured in inches along individual axes as described in following paragraphs and shown on Figure 11. In addition to these station lines, fuselage stations and water lines may be used as references. All vertical stabilizer station line axes are on BL 0.0, the vertical reference plane established for fuselage and airplane lateral reference. Figure 12 shows an example for locating a specific point on the vertical stabilizer.

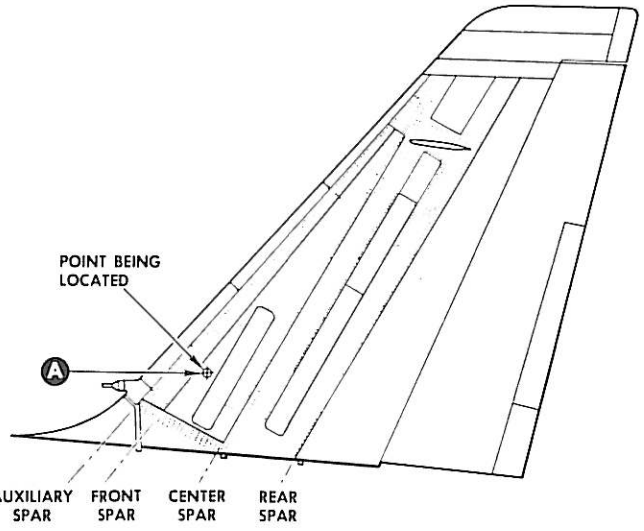
Vertical stabilizer spanwise or horizontal reference lines are airplane water lines extrapolated from fuselage water lines. Therefore they are parallel to, and are measured vertically from, the horizontal reference plane established at fuselage WL 0.0. The basic water line for vertical

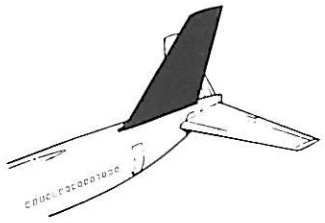


Vertical Stabilizer Station Diagram
Figure 11 (Sheet 1 of 2)

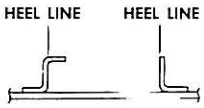


Vertical Stabilizer Station Diagram
Figure 11 (Sheet 2 of 2)

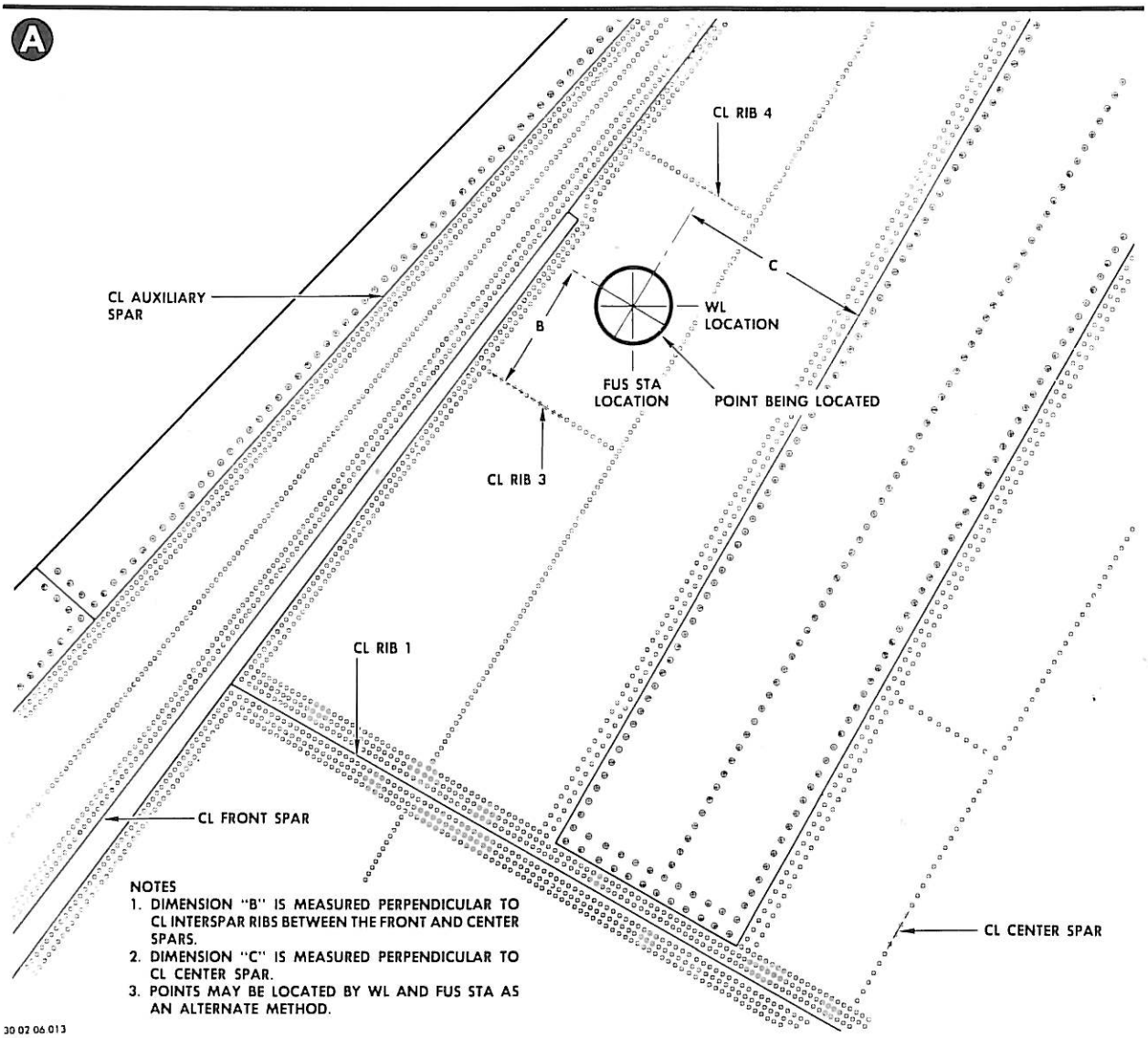




LOCATE POINTS ON INTERIOR STRUCTURE BY MEASURING FROM THE HEEL LINE ON ANGLES, ZEES, ETC., SHOWN BELOW.



INTERIOR STRUCTURE



NOTES
1. DIMENSION "B" IS MEASURED PERPENDICULAR TO CL INTERSPAR RIBS BETWEEN THE FRONT AND CENTER SPARS.
2. DIMENSION "C" IS MEASURED PERPENDICULAR TO CL CENTER SPAR.
3. POINTS MAY BE LOCATED BY WL AND FUS STA AS AN ALTERNATE METHOD.

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Locating a Specific Point on Vertical Stabilizer
Figure 12

stabilizer reference is WL 135.00, below the vertical stabilizer main structure and projecting through lower portions of the rudder and rudder trim tab. The vertical stabilizer tip is at WL 389.0, the highest point on the airplane.

Vertical stabilizer leading edge rib stations are measured along the centerline of the auxiliary spar from a zero reference point at the intersection of the auxiliary spar centerline and WL 135.0 at fuselage station 1410.8. These rib stations are perpendicular to the auxiliary spar centerline, which is on the 5.5% chord line.

Vertical stabilizer interspar rib stations between the auxiliary and front spars are measured along the centerline of the front spar from a zero reference point at the intersection of the front spar centerline and WL 135.0 at fuselage station 1428.61. These rib stations are perpendicular to the front spar centerline, which is on the 12.6% chord line.

Vertical stabilizer interspar rib stations between the front and rear spars are measured along the centerline of the rear spar from a zero reference point at the intersection of the rear spar centerline and WL 135.0 at fuselage station 1522.45. These rib stations are perpendicular to the rear spar centerline, which is on the 50% chord line.

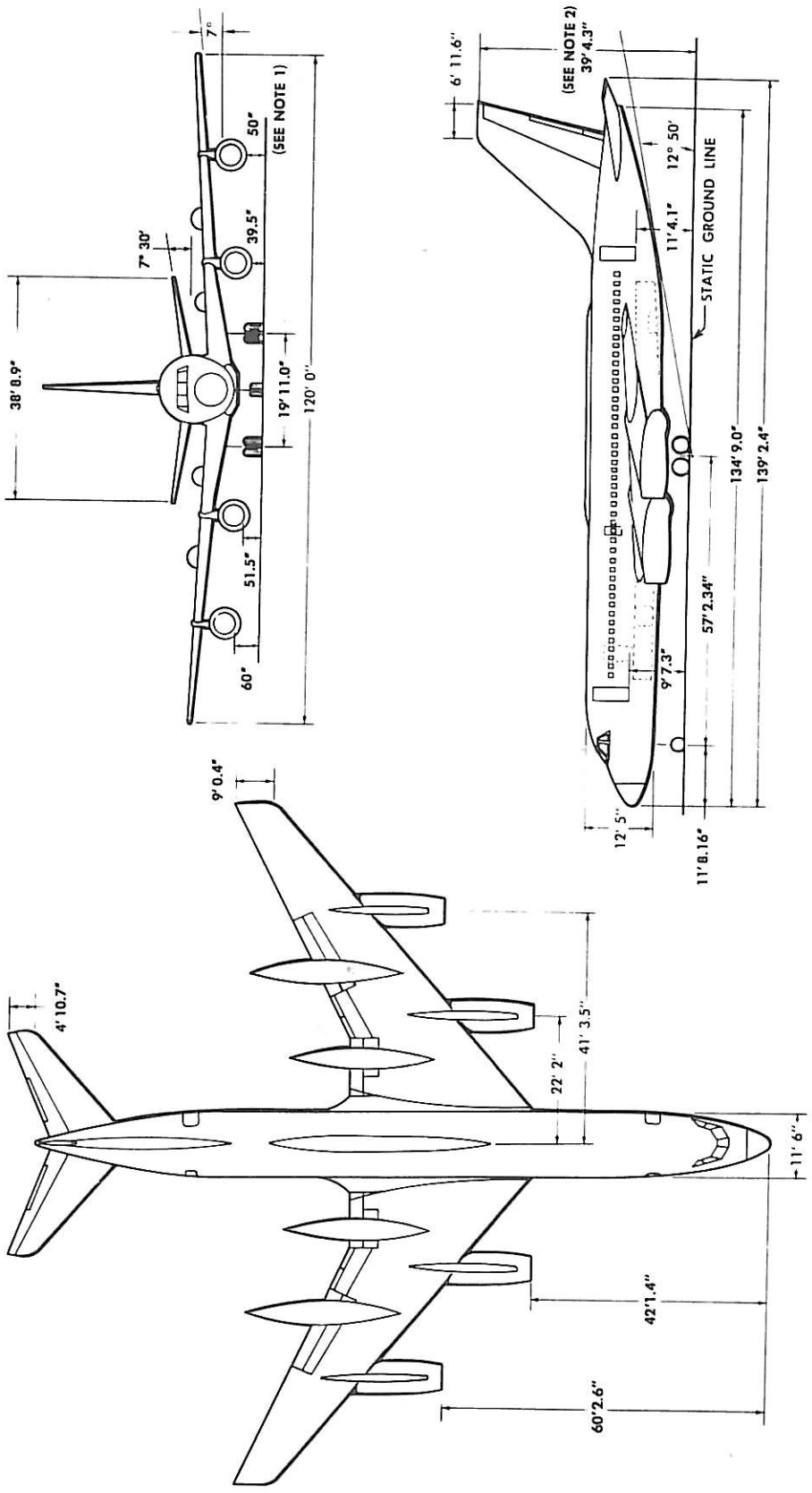
Rudder hinge centerline stations are measured along the rudder hinge line from a zero reference point at the intersection of the rudder hinge line and WL 135.0 at fuselage station 1572.63. These rudder hinge centerline stations are perpendicular to the rudder hinge line, which is on the 70% chord line.

Rudder rib station lines are measured along the rudder hinge line from a zero reference point at the intersection of the rudder hinge line and WL 135.0 at fuselage station 1572.63. The ribs from rudder rib stations 16.23 through 83.77 are at an 86-degree angle to the rudder hinge line. The ribs from rudder rib station 86.77 and up are perpendicular to the rudder tabs hinge line.

Rudder trim and flight tab stations are measured along the tabs hinge line from a zero reference point at the intersection of the tabs hinge line and WL 135.0 at fuselage station 1632.85. These rudder tab hinge line stations are perpendicular to the rudder tabs hinge line, which is on the 94% chord line.

6. Dimensions

The principal dimensions of the airplane are shown on Figure 13 and are listed below, along with other pertinent data.



NOTE

1. ENGINE POD CLEARANCE AND AIR INTAKE HEIGHT DIMENSIONS PREVAIL ONLY DURING AIRPLANE MANUFACTURE. FULL FUEL LOADS DEPRESS INBOARD ENGINE PODS 1.5 INCHES AND OUTBOARD ENGINE PODS 8.0 INCHES.
2. VERTICAL STABILIZER HEIGHT DIMENSION SHOWN IS WITH AIRPLANE AT FULL GROSS WEIGHT. THIS HEIGHT WILL INCREASE FROM FOUR TO SIX INCHES WITH AIRPLANE AT EMPTY WEIGHT.

30.30.06.003 B

Airplane Three-View
Figure 13

Wing

Span	120 feet 0 inches
Airfoil Section	
Root (Extended Chord)	NACA 0011-64 modified
31.5% Semi-Span (Break)	NACA 0009-64 modified
Tip	NACA 0008-64 modified
Chord at Root (Basic)	29 feet 1.8 inches
Chord at Root (Extended)	35 feet 8.4 inches
Chord at Tip (Basic)	8 feet 10 inches
Chord at Tip (Actual)	9 feet 0.4 inches
Mean Aerodynamic Chord (Basic)	20 feet 9.7 inches
Aspect Ratio	6.2
Taper Ratio (Basic)	0.303
Sweepback (At Wing 30% Chord Line)	35 degrees
Incidence (Root)	4 degrees
Dihedral (At Manufacturing Chord Plane)	7 degrees
Wing Trailing Edge Flaps	Double Slotted
Ailerons (Semi-Span at Leading Edge)	9 feet 7.5 inches
Anti-Shock Bodies	
Overall Length - Inboard Body	22 feet 9.9 inches
Overall Length - Outboard Body	24 feet 5.9 inches
Maximum Radius - Inboard Body	1 foot 8 inches
Maximum Radius - Outboard Body	2 feet 1.5 inches
Engine Pod Clearance (Three-Point Position)	
Inboard Engine Pod Jig Dimension	3 feet 3.5 inches
Outboard Engine Pod Jig Dimension	4 feet 2.0 inches

Horizontal Stabilizer

Span	38 feet 8.9 inches
Airfoil Section	
Root	NACA 0009.5-64 modified
Tip	NACA 0008-64 modified
Chord at Root	17 feet 1.5 inches
Chord at Tip	4 feet 10.7 inches
Mean Aerodynamic Chord - Basic	12 feet 1.7 inches
Mean Aerodynamic Chord - Exposed	10 feet 7.5 inches
Aspect Ratio	3.52
Taper Ratio	0.286
Sweepback (At 27.78% Chord Line)	35 degrees
Incidence	
Down	14 degrees
Up	2 degrees
Dihedral	7 degrees 30 minutes

Vertical Stabilizer

Height (Tip Above Ground, Airplane Loaded)	39 feet 4.3 inches

Airfoil Section	
Root	NACA 0010-64 modified
Tip	NACA 0008-64 modified
Chord at Root	20 feet 10.9 inches
Chord at Tip	6 feet 11.6 inches
Aspect Ratio	1.52
Taper Ratio	0.33
Sweepback (At 30% Chord Line)	35 degrees

Fuselage

Length (Overall)	134 feet 9 inches
Height (Maximum)	12 feet 5 inches
Width (Maximum)	11 feet 6 inches
Doors	
Entrance (2)	30 x 74 inches
Service (2)	30 x 48 inches
Cargo (Forward Compartment)	48 x 59 inches
Cargo (Aft Compartment, Forward Door)	48 x 59 inches
Cargo (Aft Compartment, Aft Door)	35 x 45 inches
Emergency (2)	20 x 36 inches

Landing Gear

Wheelbase (Airplane)	57 feet 2.3 inches
Wheelbase (Main Gear Trucks)	3 feet 10.5 inches
Tread	
Airplane (Main Gear Centerlines)	19 feet 11 inches
Main Gear Truck Wheels	2 feet 0 inches
Nose Gear Wheels	1 foot 5 inches
Nose Gear Wheel Centerline to Airplane Nose	11 feet 8.2 inches

7. Areas and Volumes

Wing (Total)	2250 square feet
Horizontal Stabilizer (Total)	426.6 square feet
Elevator (Aft of Hinge, Including Tabs)	97.6 square feet
Elevator Flight Tab (Aft of Hinge)	7.3 square feet
Elevator Trim Tab (Aft of Hinge)	2.9 square feet
Vertical Stabilizer (Total)	295 square feet
Rudder (Aft of Hinge, Including Tabs)	82.6 square feet
Rudder Balance	45.3 square feet
Rudder Flight Tab (Aft of Hinge)	8.1 square feet
Rudder Trim Tab (Aft of Hinge)	3.8 square feet
Forward Cargo Compartment (Basic)	488 cubic feet
Aft Cargo Compartment (Basic)	440 cubic feet

LIST OF EFFECTIVE PAGES

Chapter 7
LIFTING AND SHORING

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	7	1	Aug. 30/61	AB-1
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Chapter 7
LIFTING AND SHORING

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CHAPTER 7

LIFTING AND SHORING - DESCRIPTION AND OPERATION

1. General

At various times during maintenance and overhaul it will be necessary to lift and shore the airplane or its major components. Raising of the airplane by jacks will be required for ground operation of landing gears, servicing of components, and leveling and weighing the airplane. Jacking at landing gears will be required for servicing wheels, tires, and brakes, and for weighing the airplane. Shoring of the fuselage and wings should be considered whenever structural repairs are to be made on these components.

LIFTING - DESCRIPTION AND OPERATION

1. General

Lifting the airplane consists of operations such as jacking the entire airplane, jacking at each landing gear, and raising the entire airplane with pneumatic lifting bags. Jacking provisions for raising the entire airplane are incorporated in each wing and in the fuselage nose. Jack pads for individual gear jacking are provided by integral lugs on the main and nose landing gears. Although infrequently used, pneumatic lifting bags provide a means of raising the airplane following a wheels-up landing, or supporting the airplane under unusual circumstances. The airplane must not be jacked in winds exceeding 35 knots. Other precautions such as removing all unnecessary equipment in the area and checking overhead clearances must be observed.

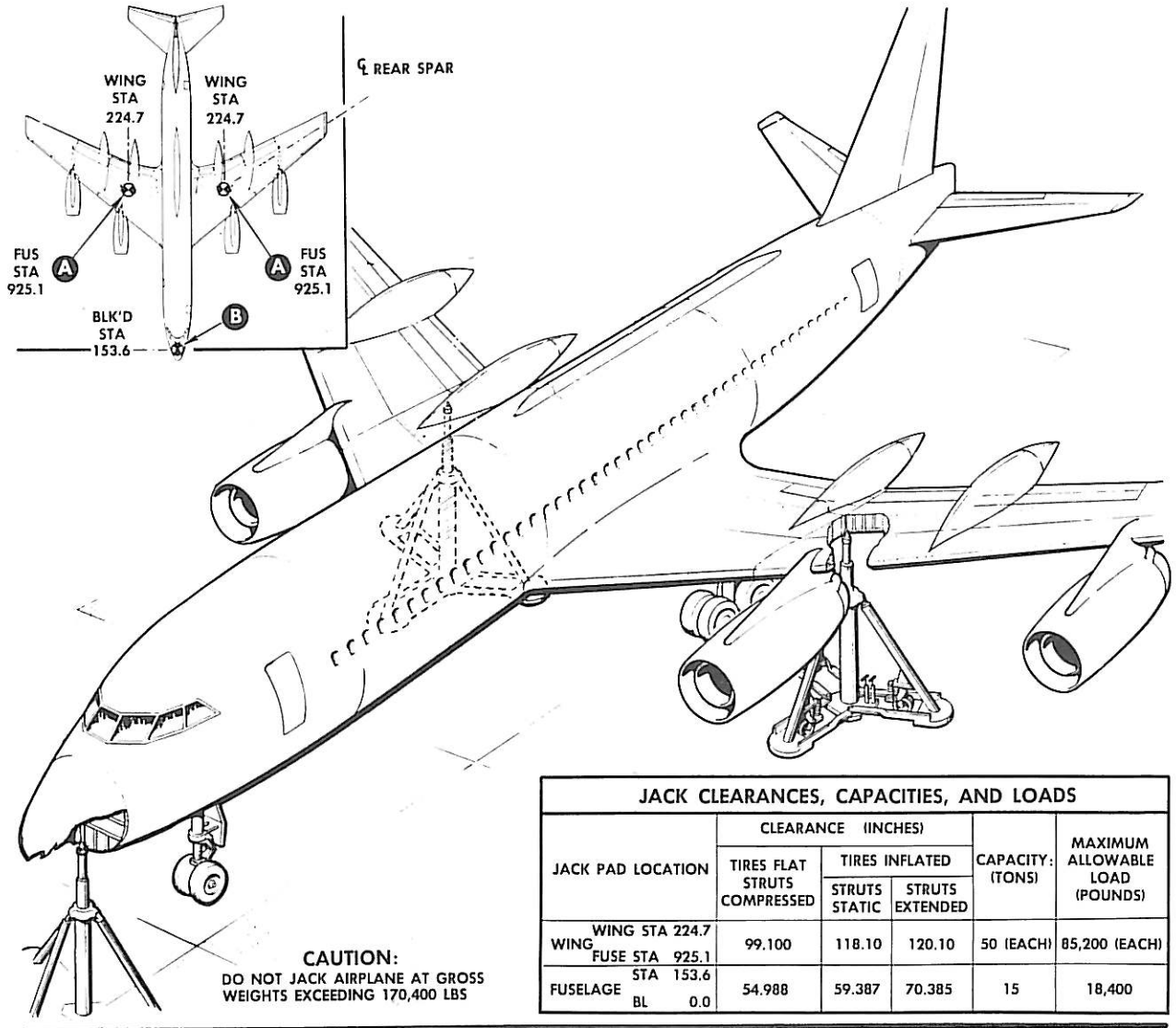
2. Jacking the Entire Airplane

The entire airplane may be raised using the three airplane structural jack points shown on Figure 1. The fuselage jack point is at fuselage station 153.6, forward of the nose landing gear wheel well; the two wing jack points are on wing station 224.754, about four inches aft of the rear spar centerline, and even with fuselage station 925.1. When not in use, the jack fitting openings are filled with flush inserts to maintain aerodynamic smoothness. Jacking operations should be simultaneous to keep the airplane in a level attitude; this is to minimize side loads and to prevent jack overloading.

A restraining clamp may be used on each landing gear strut to prevent the strut from extending while the airplane is being raised. When restraining clamps are used the landing gear oleo struts must be deflated. These clamps will not support the weight of the landing gear in addition to the tension applied against the clamps by the inflated oleo struts.

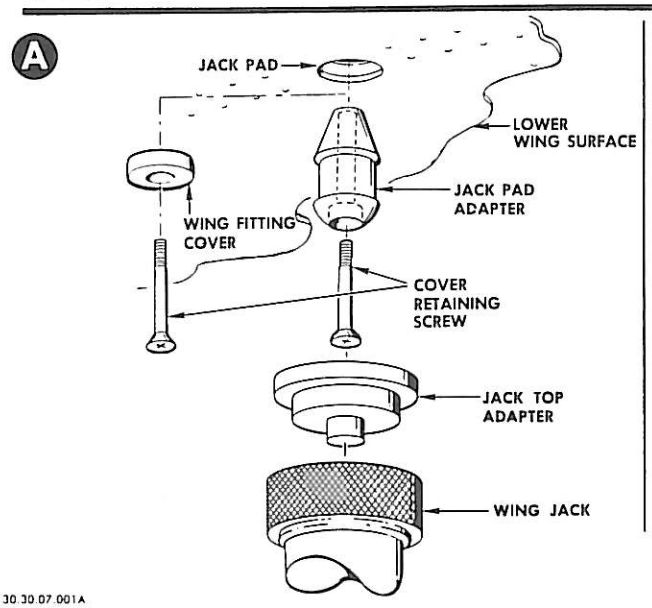
3. Jacking at the Landing Gears

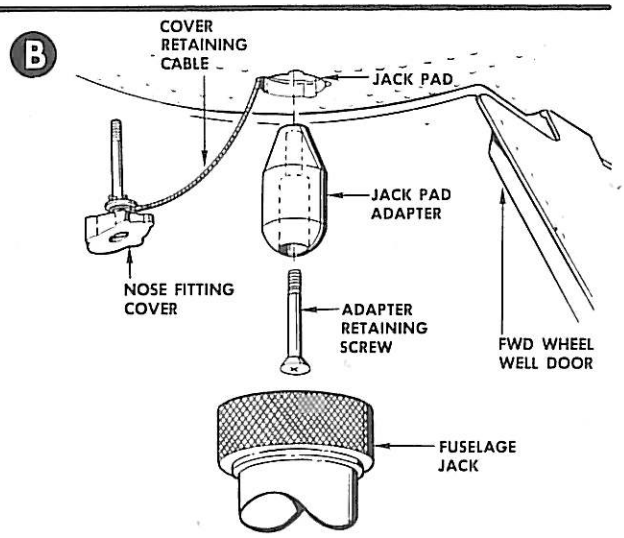
Three integral lugs are incorporated on each main landing gear truck, one below the truck pivot on the strut centerline, and one below each wheel axle centerline. The jacking lug on the nose landing gear is about ten inches forward of the nose wheel axle centerline. These seven jack points enable the gears and wheels to be raised individually for servicing. Downlock safety pins must be installed in the side braces of the main landing gears and in the drag brace of the nose landing gear to prevent them from inadvertently retracting. Main landing gear wheel or brake servicing is made possible by raising the front or rear of the main gear trucks with jacks under the individual pads as shown on Figure 2. A jacking tool that may be used when four main landing gear tires are flat is shown on Figure 3. The jacking limit dimensions shown on Figure 4 must not be exceeded when jacking at the main landing gear. When jacking under any landing gear lift the gear only high enough to clear the tires from the ground.



CAUTION:
DO NOT JACK AIRPLANE AT GROSS WEIGHTS EXCEEDING 170,400 LBS

JACK CLEARANCES, CAPACITIES, AND LOADS						
JACK PAD LOCATION		CLEARANCE (INCHES)			CAPACITY: (TONS)	MAXIMUM ALLOWABLE LOAD (POUNDS)
		TIRES FLAT STRUTS COMPRESSED	TIRES INFLATED			
			STRUTS STATIC	STRUTS EXTENDED		
WING	WING STA 224.7 FUSE STA 925.1	99.100	118.10	120.10	50 (EACH)	85,200 (EACH)
FUSELAGE	STA 153.6 BL 0.0	54.988	59.387	70.385	15	18,400





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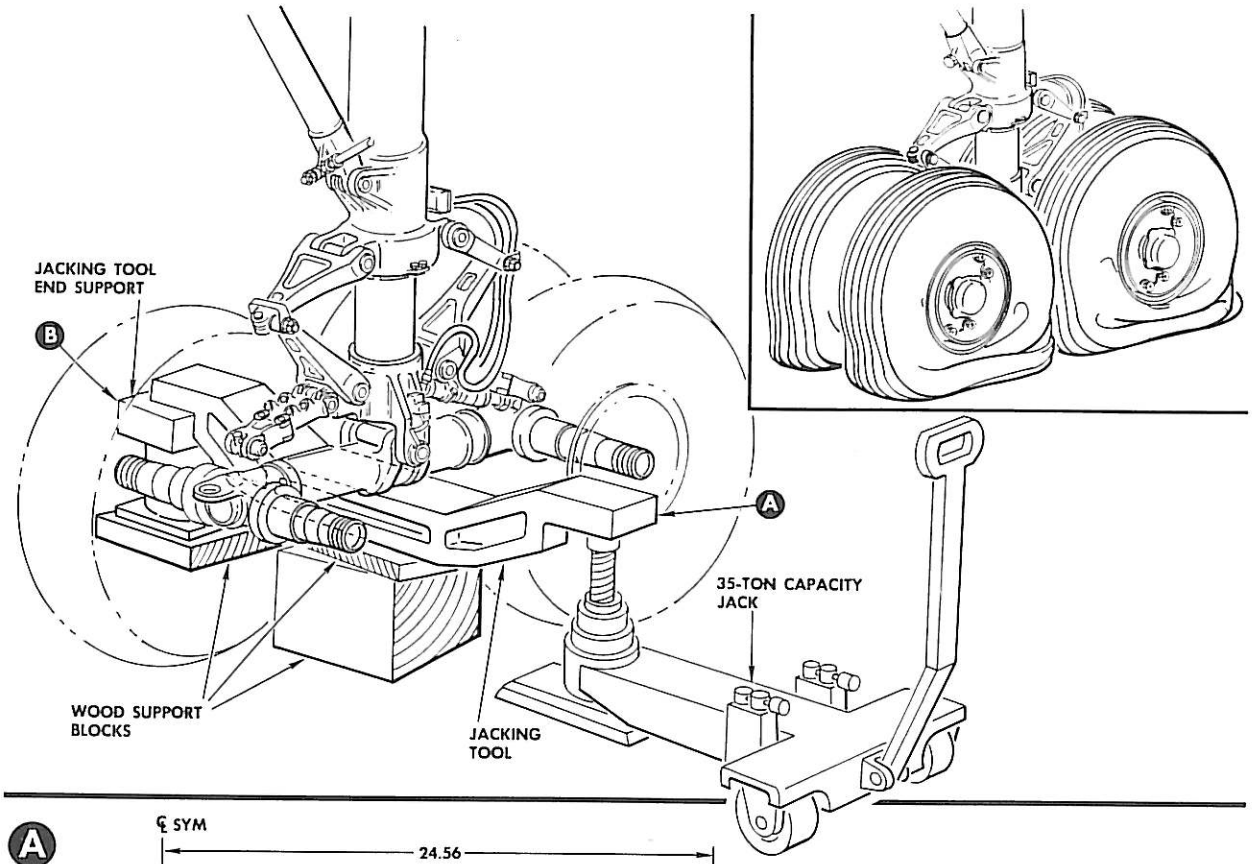
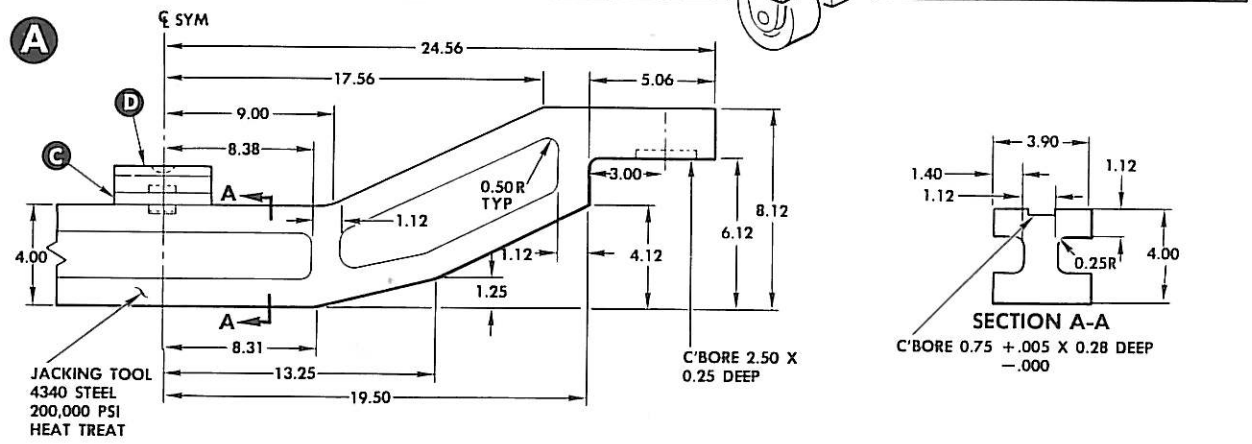
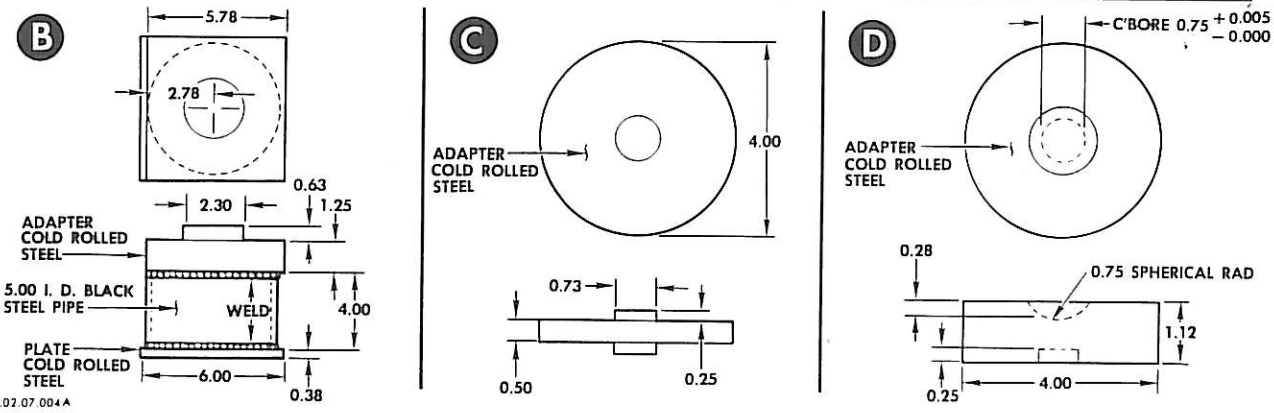
Fuselage and Wing Jack Points
Figure 1

JACK CLEARANCES, CAPACITIES, AND LOADS

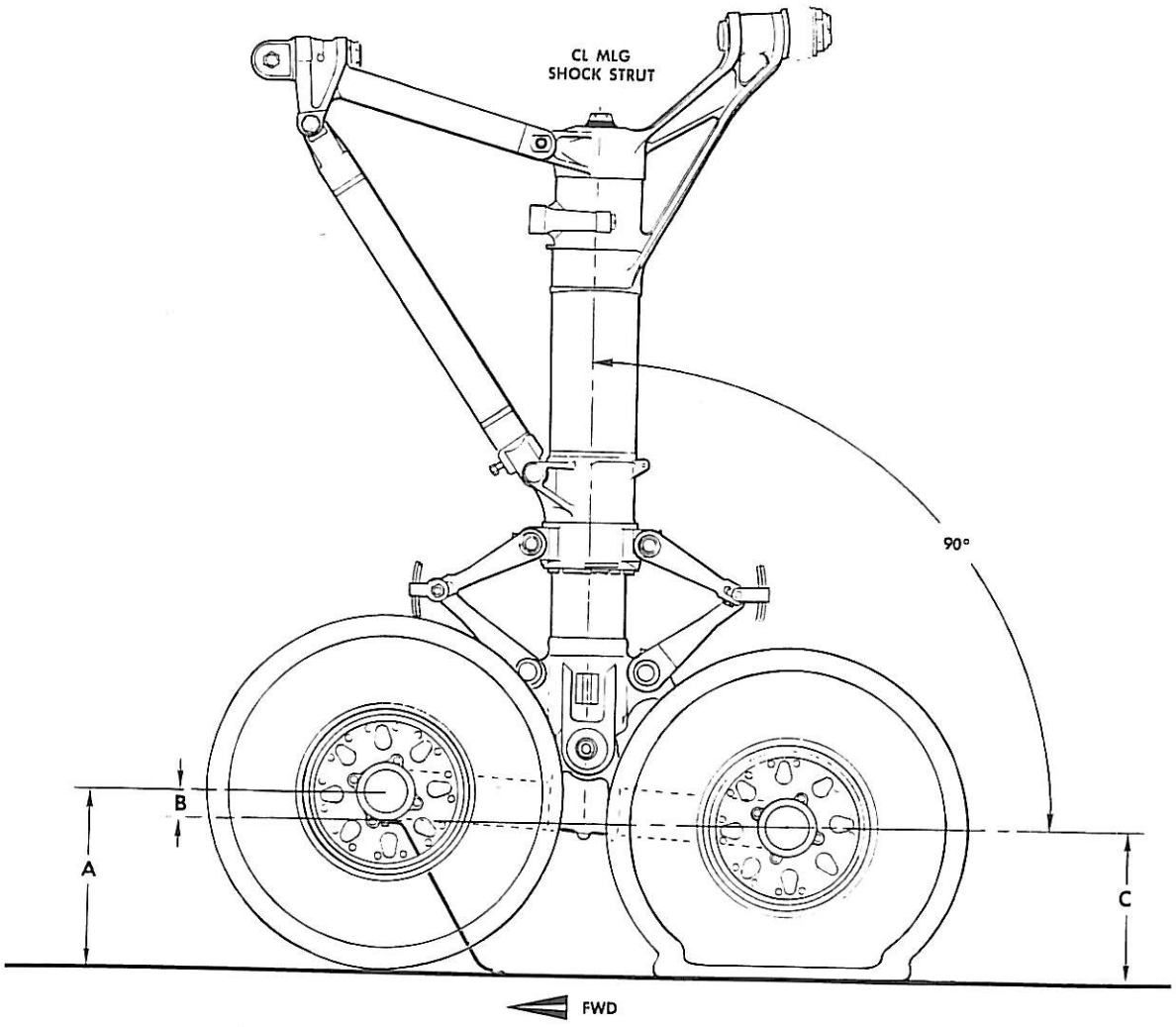
LANDING GEAR JACK POINT LOCATION		CLEARANCE (INCHES)					CAPACITY (TONS)	MAXIMUM ALLOWABLE LOAD (POUNDS)
		TIRES INFLATED	2 FLAT TIRES	4 FLAT TIRES	2 WHEELS ON RIMS	4 WHEELS ON RIMS		
MAIN LANDING GEAR STRUT		13.50	11.56	9.70	8.88	4.50	60 (EACH)	116,500 (EACH)
MAIN LANDING GEAR TRUCK	FOR-WARD	13.62	9.82	9.82	4.62	4.62	30 (EACH)	57,500 (EACH)
	AFT	13.62	9.82	9.82	4.62	4.62	30 (EACH)	59,000 (EACH)
NOSE LANDING GEAR STRUT		14.05	11.65	—	10.35	—	15	20,700







Main Landing Gear Jacking Tool
(Four Tires Flat)
Figure 3



MAIN LANDING GEAR TRUCK BEAMS JACKING LIMIT DIMENSIONS AT FORWARD AND AFT JACK PADS

LIMITS (INCHES)	4 TIRES FLAT		RIMS ON GROUND OR NO TIRES		2 TIRES INFLATED SAME AXLE 2 TIRES FLAT SAME AXLE JACK UNDER FLAT TIRES AXLE	
	FWD	AFT	FWD	AFT	FWD	AFT
A	20.17		14.97		23.97	
B	6.47	6.91	6.47	6.91	6.47	6.91
C		20.61		15.41		24.41

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4. Jacking at a Main Landing Gear When Four Tires Are Flat

A special jacking tool may be made to raise the main landing gear as shown on Figure 3 when all four tires are flat on one main gear. The down-lock safety pins must be installed in all landing gears. The special jacking tool is inserted between the forward and aft tires and is positioned under the jack pad on the centerline of the main strut. A 30-ton capacity jack is placed under one end of the tool and a support block is placed under the other end. Raising the landing gear is accomplished by jacking at the one end of the tool until a support block can be placed under the center of the tool; then building up the height of the end support block and repeating the procedure until the landing gear has been raised high enough to replace the four flat tires.

5. Lifting Clearances

A. Wing and Fuselage Jack Clearances.

Clearances between the wing and fuselage jack pads and the surfaces upon which jacks are placed are tabulated on Figure 1 for various conditions.

B. Landing Gear Jack Clearances.

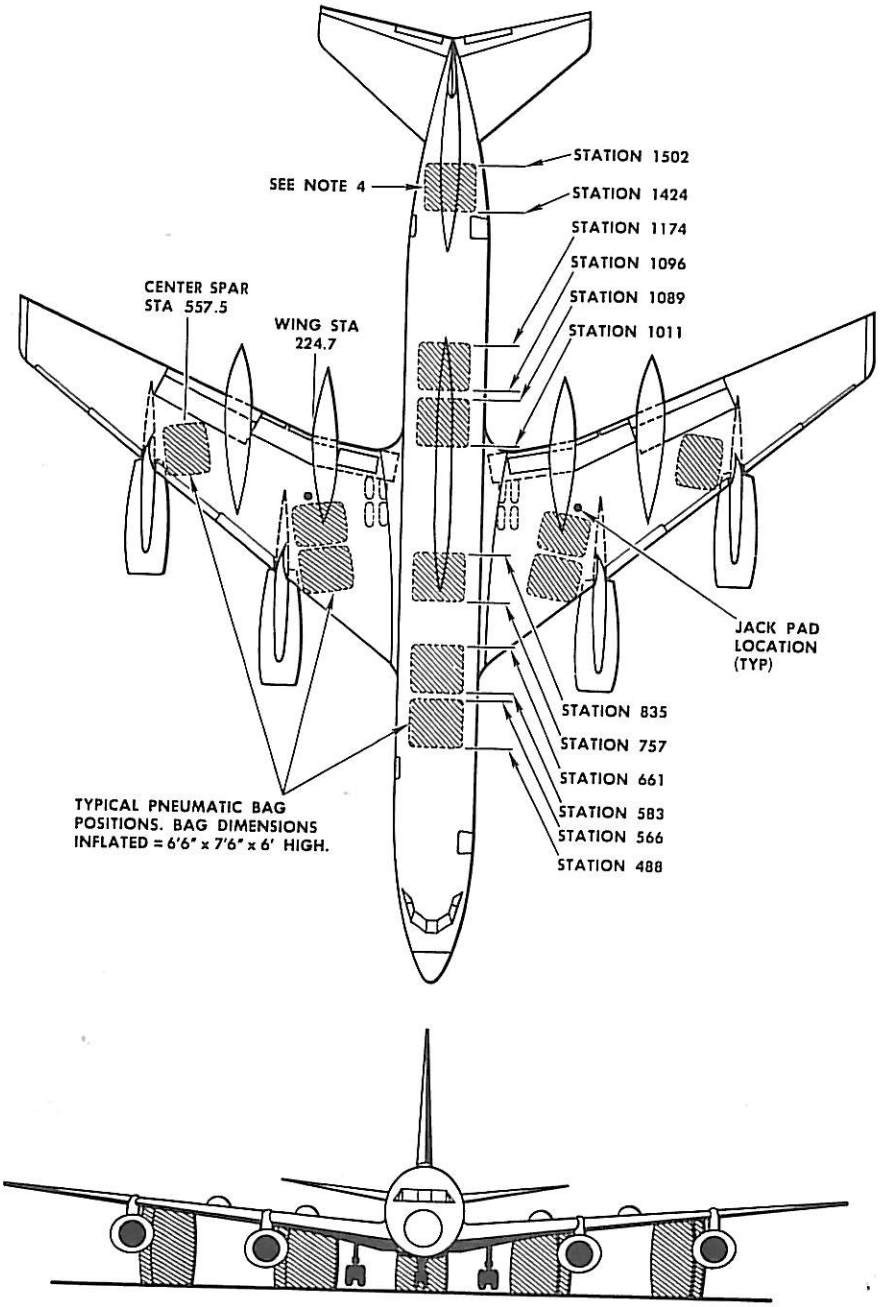
Clearances between the landing gear jack pads and the surfaces upon which jacks are placed are tabulated on Figure 2 for various conditions.

6. Lifting Airplane with Pneumatic Bags

When conditions prohibit normal lifting procedures during emergencies, the airplane can be raised with pneumatic bags as shown on Figure 5. Type F-2 lifting bags, manufactured by the U.S. Rubber Company (or equivalent), may be used to raise the airplane enough for it to be shored, or for it to be supported by the landing gears or by airplane jacks. These bags may be inflated to a height of six feet; they have a unit lifting capacity of 12 tons. When necessary, the bags may be stacked and laced together, and manifolded to receive air simultaneously. Each lifting bag has a protective tarpaulin cover for storage.

Lifting procedures may differ depending upon the extent of airplane damage, the wind conditions, and the terrain. The airplane should be lightened as much as possible by removing all baggage and loose equipment, and if possible it should be defueled. The underside of the airplane should be examined for sharp or rough projections which could puncture the bags. Felt pads and the storage covers may be used to provide additional bag protection.

When it has been lifted to a sufficient height, shoring or jacks should be used to support the airplane. In some cases it may be possible to extend and lock the landing gears. The lifting bags should not be used to support the airplane in lieu of standard equipment designed for the purpose.



NOTES:
1. AIRPLANE WEIGHT MUST BE REDUCED TO ABSOLUTE MINIMUM. MAXIMUM LOAD PERMISSIBLE ON EACH BAG = 24,000 LBS.
2. BAGS CENTRALLY LOCATED UNDER WING SPLICE AREA ALLOWING CLEARANCE FOR PLACING JACKING EQUIPMENT AT STRUCTURAL JACK POINTS.
3. BAG CENTRALLY LOCATED AROUND AREA OF WING SKIN SPLICE (APPROXIMATELY 30 INCHES INBOARD OF ENGINE PYLON) AND WING CENTER SPAR.
4. EACH FUSELAGE BAG SHALL PICK UP AT LEAST FOUR FRAMES.

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AIRPLANE JACKING - MAINTENANCE PRACTICES

1. Preparation

Before lifting the airplane it should be lightened as much as practicable by defueling, drawing the liquids from other tanks, removing unnecessary equipment, and the like. Overhead, underwing, undertail, and underbody areas should be inspected for clearances and all possible hazards that might damage the airplane should be removed.

CAUTION: DO NOT RAISE THE AIRPLANE IN WINDS EXCEEDING 35 KNOTS.

2. Jacking at the Fuselage and Wing Structural Jack Points

A. General.

The airplane is provided with three structural jack points; one near the fuselage nose and one under each wing, as shown on Figure 1. The total maximum allowable gross weight for jacking at the fuselage and wing structural jack points is 170,400 pounds. The maximum jacking load allowed at the fuselage nose jack point is 18,400 pounds. The maximum jacking load allowed at each of the wing jack points is 85,200 pounds.

CAUTION: DO NOT JACK THE AIRPLANE IN WINDS EXCEEDING 35 KNOTS.

B. Equipment Required.

(1) One Fuselage Jack Pad Adapter (Convair 22J112 or equivalent).

(2) Two Wing Jack Pad Adapters, as shown on Figure 201.

(3) Two Wing Jack Top Adapters, as shown on Figure 201.

(4) One Nose Landing Gear Strut Restraining Clamp (Convair 22J124 or equivalent).

(5) Two Main Landing Gear Strut Restraining Clamps, as shown on Figure 202.

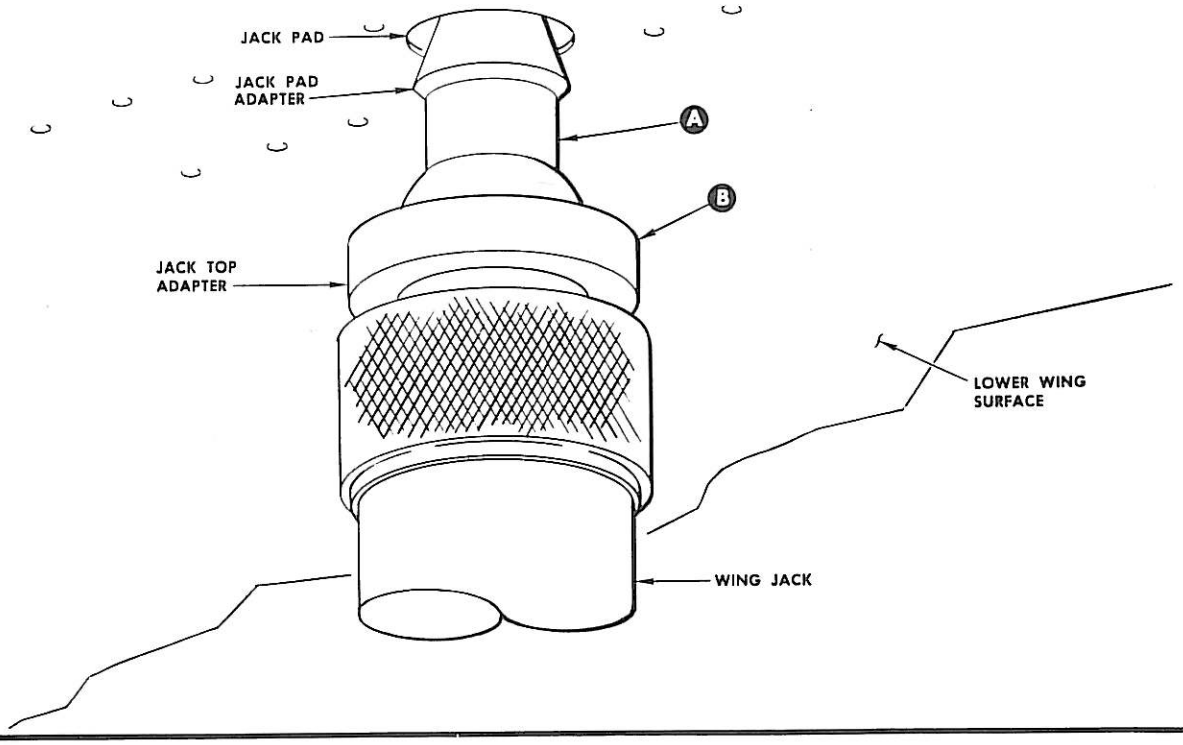
(6) One 15-Ton Hydraulic Fuselage Tripod Jack (Regent Model No. 2958 or equivalent).

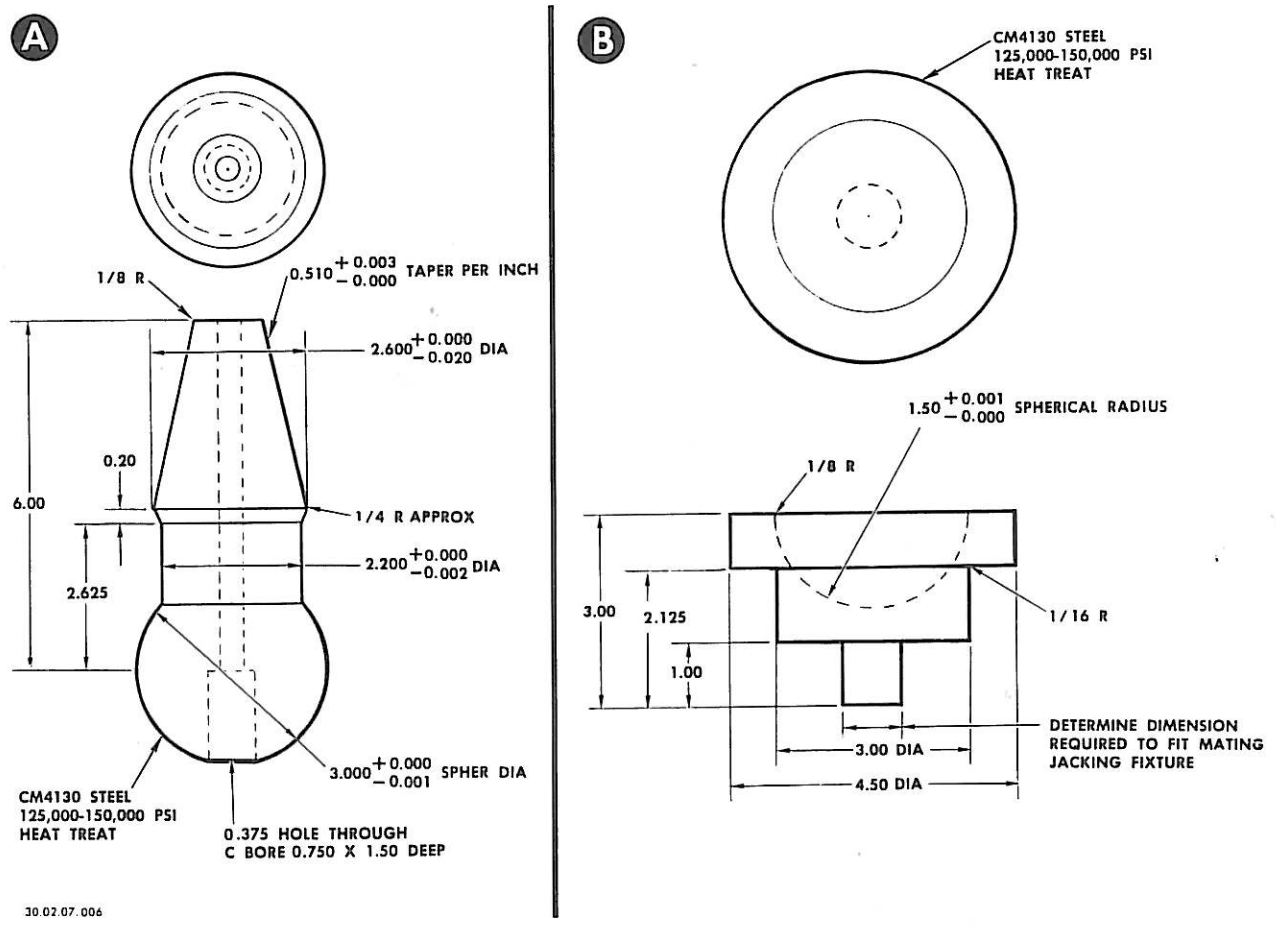
(7) Two 50-Ton Hydraulic Wing Tripod Jacks (Regent Model No. 2955 or equivalent).

C. Jacking Procedure.

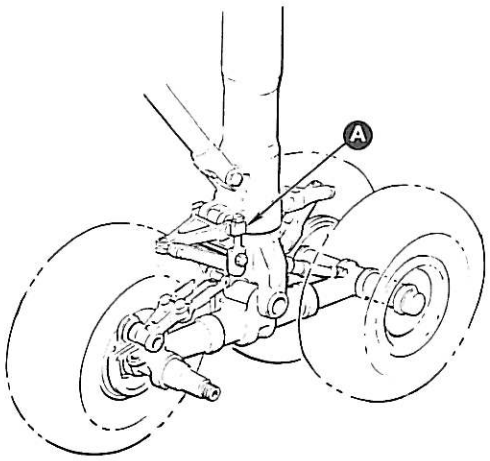
(1) Move airplane onto most level hard surface available and turn its nose into wind if in an exposed area.

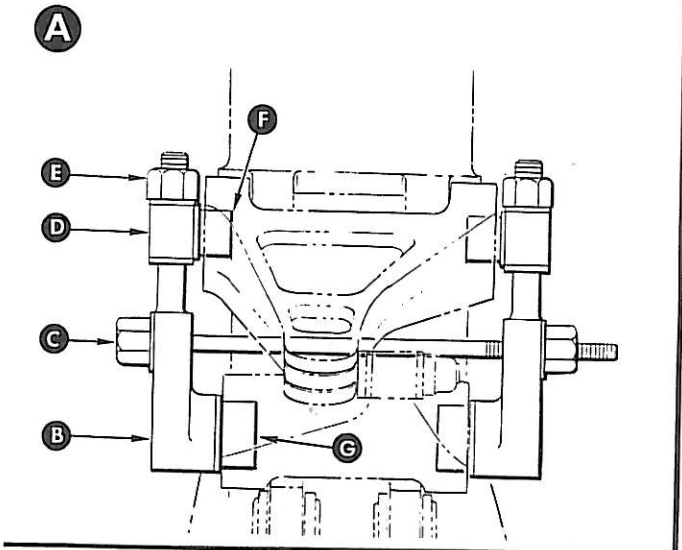
(2) Install down-lock safety pins in all landing gears.

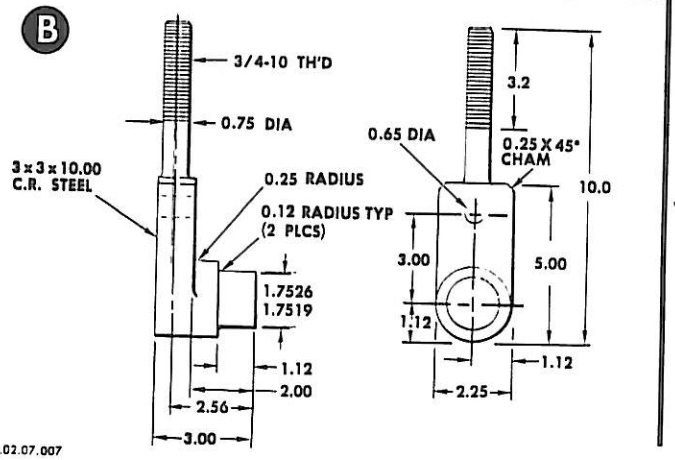




Wing Jack Pad and Jack Top Adapters
Figure 201







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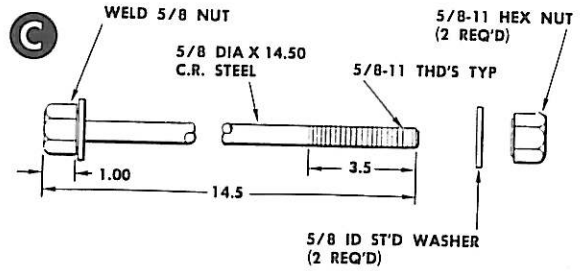
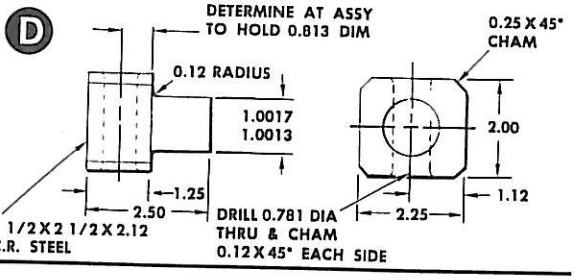
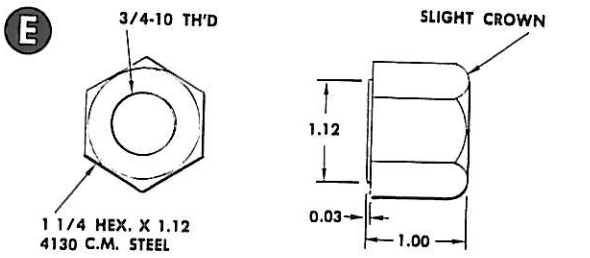
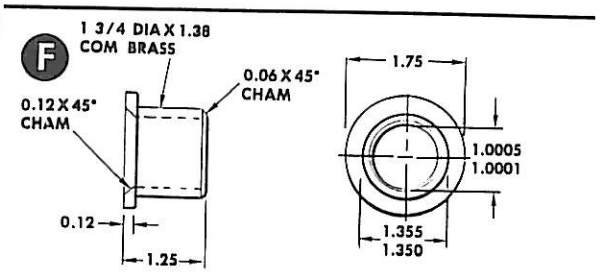
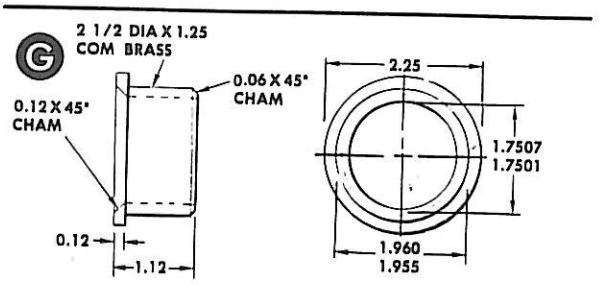










STANDARD DRAWING TOLERANCE	
DIMENSION	TOLERANCE
ONE DECIMAL (0.0)	0.1
TWO DECIMAL (0.00)	0.03

(3) Completely deflate nose gear strut and install restraining clamp (22J124) to prevent strut extension when airplane is raised.

(4) Completely fill main landing gear truck beam positioner cylinder with oil to prevent main landing gear rear wheels from dropping when airplane is raised.

(5) Completely deflate both main landing gear struts and install a restraining clamp (Figure 202) on each strut to prevent strut extension when the airplane is raised.

(6) Remove flush cover at fuselage jack point and install fuselage nose jack pad adapter (22J112) with 10-32 adapter retaining screws.

(7) Remove flush covers at wing jack points and install wing jack pad adapters (Figure 201) with 10-32 adapter retaining screws.

(8) Move 15-ton fuselage jack into place under fuselage nose jack pad adapter, positioning jack with one jack leg pointing forward, and carefully centering jack directly under jack pad adapter.

(9) Move 50-ton wing jacks under wing jack pad adapters and place jack top adapters (Figure 201) on top of jacks, positioning each jack with one jack leg pointing forward, and carefully aligning jack top adapters and jacks directly under centers of wing jack pad adapters.

(10) Remove wheel chocks and release parking brakes.

(11) Station a man at each jack and raise airplane in a level attitude by operating all jacks simultaneously until all landing gear tires clear ground. Refer to Chapter 8, LEVELING AND WEIGHING, for leveling procedure if exact level condition is required.

NOTE: As jacks are raised, turn down jack ram locknuts to maintain one-inch clearance between nut and ram collar. When jacking is complete, snug up nut and tighten nut setscrew.

CAUTION: DO NOT RETRACT LANDING GEAR WITH DOWN-LOCK SAFETY PINS OR STRUT RESTRAINING CLAMPS INSTALLED, OR WITH MAIN LANDING GEAR BEAM POSITIONER CYLINDERS COMPLETELY FILLED.

D. Lowering Procedure.

(1) Clear equipment from area under airplane and make sure down-lock safety pins are installed in all landing gears.

(2) Loosen setscrew in jack ram locknut on each jack and turn nut up ram to provide one-inch clearance between nut and ram collar.

NOTE: If necessary, raise jack ram slightly to free locknut.

(3) Lower airplane in level attitude by releasing pressure slowly on all jacks simultaneously, maintaining one-inch clearance between locknut and collar at each jack.

NOTE: Jack may be raised and lowered alternately to free ram if jack "hangs up". If ram cannot be freed, raise and shore airplane while faulty jack is replaced. When weight is on landing gear, retract jack completely before removing.

(4) Remove jacks, jack pad adapters, and landing gear strut restraining clamps.

(5) Replace flush covers at fuselage and wing jack points.

(6) Reduce quantities of oil in main landing gear truck positioner cylinders to level specified in Chapter 12, SERVICING.

(7) Reinflate main and nose landing gear struts in accordance with directions on strut placards.

3. Jacking with Fuselage Jack Only

A. Equipment Required.

(1) One Fuselage Jack Pad Adapter (Convair 22J112 or equivalent).

(2) One Nose Landing Gear Strut Restraining Clamp (Convair 22J124 or equivalent).

(3) One 15-Ton Hydraulic Fuselage Tripod Jack (Regent Model No. 2958 or equivalent).

B. Jacking Procedure.

(1) Move airplane onto most level hard surface available and turn its nose into wind if in an exposed area.

CAUTION: DO NOT JACK AIRPLANE IN WINDS EXCEEDING 35 KNOTS.

(2) Install down-lock safety pins in all landing gears.

(3) Position wheel chocks firmly on aft side of each main landing gear truck and loosely on forward side.

(4) Completely deflate nose gear strut and install restraining clamp (22J124) to prevent strut extension when airplane is raised.

NOTE: Omit this step if nose is being raised for replacement of nose gear strut O-rings or for gear operation.

(5) Remove flush cover at fuselage jack point and install jack pad adapter 22J112) with 10-32 adapter retaining screw.

(6) Move 15-ton fuselage jack into place under fuselage nose jack pad adapter, position one jack leg forward, and carefully center jack directly under jack pad adapter.

(7) Release parking brakes.

(8) Raise fuselage nose. As jack is raised, turn down jack ram locknut, maintaining one-inch clearance between nut and ram collar. When jacking is complete, snug up nut and tighten nut setscrew.

C. Lowering Procedure.

(1) Clear equipment from area under fuselage nose and make sure down-lock safety pins are installed in all landing gears.

(2) Loosen setscrew in jack ram locknut on jack and turn nut up ram to provide one-inch clearance between nut and ram collar.

NOTE: If necessary, raise jack ram slightly to free locknut.

(3) Lower fuselage nose, maintaining one-inch clearance between locknut and collar.

NOTE: Jack may be raised and lowered alternately to free ram if jack "hangs up". If ram cannot be freed, raise and shore fuselage nose while faulty jack is replaced. When weight is on nose landing gear, retract jack completely before removing.

(4) Remove jack, jack pad adapter, and nose landing gear restraining clamp.

(5) Replace flush cover at fuselage nose jack point.

(6) Reinflate nose landing gear strut in accordance with directions on strut placard.

4. Jacking at the Main Landing Gear

A. General.

Each main landing gear is provided with three jack points; one under the central pivot point of the truck axle beam and one under each wheel axle, as shown on Figure 2. The maximum jacking load allowed at the forward wheel axle jack point is 57,500 pounds; the maximum jacking load allowed at the aft wheel axle jack point is 59,000 pounds. The maximum jacking load allowed at the central pivot jack point is 116,500 pounds for each main landing gear truck. The total maximum allowable airplane gross weight for jacking at landing gears is 247,000 pounds.

CAUTION: DO NOT JACK THE AIRPLANE IN WINDS EXCEEDING 35 KNOTS.

B. Equipment Required.

(1) One 75-Ton Hydraulic Main Landing Gear Alligator Jack (Regent Model No. 4968 or equivalent).

(2) One 35-Ton Main Landing Gear Wheel Axle Alligator Jack (Regent Model No. 4961 or equivalent).

C. Jacking Procedure at the Main Landing Gear Beam Center Jack Pad.

CAUTION: DO NOT JACK THE AIRPLANE IN WINDS EXCEEDING 35 KNOTS.

(1) Install down-lock safety pins in all landing gears.

(2) Chock nose wheel and opposite main landing gear wheels.

(3) Completely fill main landing gear truck beam positioner cylinder with oil to prevent rear wheels from dropping when truck is raised.

(4) Move 75-ton alligator jack under pad at centerline of main landing gear strut, as shown on Figure 2, and carefully center jack head directly under jack pad.

(5) Release parking brakes.

(6) Raise main landing gear truck.

CAUTION: AFTER COMPLETING MAINTENANCE OPERATIONS AND LOWERING TRUCK TO GROUND, REDUCE QUANTITY OF OIL IN MAIN LANDING GEAR TRUCK POSITIONER CYLINDER TO LEVEL SPECIFIED IN CHAPTER 12, SERVICING.

D. Jacking Procedure at the Main Landing Gear Forward or Aft Axle Jack Pad.

CAUTION: DO NOT JACK THE AIRPLANE IN WINDS EXCEEDING 35 KNOTS.

(1) Install down-lock safety pins in all landing gears.

(2) Chock nosewheel and opposite main landing gear wheels.

(3) Move 35-ton alligator jack under axle jack pad of wheels to be raised, as shown on Figure 2, and carefully center jack head directly under jack pad.

(4) Release parking brakes.

(5) Raise main landing gear wheel axle.

CAUTION: DO NOT RAISE WHEEL AXLE HIGHER THAN JACKING LIMIT DIMENSIONS SHOWN ON FIGURE 4. (MAXIMUM LIMIT IS 6.47 INCHES AT FORWARD AXLE AND 6.91 INCHES AT AFT AXLE.)

5. Jacking at the Nose Landing Gear Jack Pad

A. General.

The nose landing gear is provided with a jack pad at the lower end of the strut, under the anti-skid mechanism, as shown on Figure 2. The maximum jacking load permitted at this jack point is 20,700 pounds. The total maximum allowable airplane gross weight for jacking at landing gears is 247,000 pounds.

B. Equipment Required.

(1) One 35-Ton Main Landing Gear Wheel Axle Alligator Jack (Regent Model No. 4961 or equivalent).

(2) One Nose Landing Gear Steering Rig Pin (National Water Lift 125088 or equivalent).

C. Jacking Procedure.

CAUTION: DO NOT JACK THE AIRPLANE IN WINDS EXCEEDING 35 KNOTS.

(1) Install down-lock safety pins in all landing gears.

(2) Position wheel chocks firmly on aft side of each main landing gear truck wheel and loosely on forward side.

(3) Lock nose steering mechanism in center position with steering rig pin.

(4) Move 35-ton alligator jack under jack pad below anti-skid mechanism at lower end of strut, as shown on Figure 2, and carefully center jack head directly under jack pad.

(5) Release parking brakes.

(6) Raise nose landing gear assembly.

6. Jacking at a Main Landing Gear When Four Tires Are Flat

A. Equipment Required.

(1) One 35-Ton Main Landing Gear Wheel Axle Alligator Jack (Regent Model No. 4961 or equivalent).

(2) One Special Jacking Tool and Related Parts (as shown on Figure 3 or equivalent).

B. Jacking Procedure.

CAUTION: DO NOT JACK THE AIRPLANE IN WINDS EXCEEDING 35 KNOTS.

(1) Install down-lock safety pins in all landing gears.

(2) Chock nose wheel and opposite main landing gear wheels.

(3) Completely fill main landing gear truck beam positioner cylinder with oil to prevent rear wheels from dropping when truck is raised.

(4) Position special jacking tools under center jack pad at strut centerline, as shown on Figure 3.

(5) Position 35-ton alligator jack under one end of special jacking tool and support block under other end.

(6) Jack end of tool about 2 inches, place support block under center of special jacking tool, and lower alligator jack until landing gear truck beam rests on jacking tool and center support block.

(7) Add additional support blocks under jacking tool support block end to compensate for amount jacked end is raised.

(8) Repeat steps (6) and (7) until flat tires clear ground enough to be replaced.

7. Lifting Airplane with Pneumatic Bags

A. Equipment Required.

(1) Twelve or more pneumatic lifting bags (U.S. Rubber Company Type F-2 or equivalent).

(2) Wing and fuselage tripod jacks and jack pad adapters, as required for airplane jacking when the terrain permits safe foundations for using jacks.

(3) Felt pads, fork lift pallets, and shoring material, as required.

B. Lifting Procedure.

(1) Lighten airplane as much as possible by removing all loose equipment and baggage. When possible, airplane should be defueled and liquids drawn from other airplane tanks.

(2) Inspect undersides of airplane for sharp, rough, or abrasive projections or surfaces that might puncture or damage pneumatic bags. Cover tops of bags with felt pads to provide adequate protection from injurious areas. Use tarpaulin covers under bags for protection from rough ground areas or bag supports.

(3) Position bags under wing and fuselage surfaces at main structural areas so that lifting loads will be evenly distributed, as shown on Figure 5. Two bags must be centrally located under each wing splice area along wing station 224.7, and one bag must be placed under each wing skin splice area at center spar station 557.5, about 25 inches inboard of outboard engine pod pylons. Six, or more bags must be located under fuselage, at stations shown on Figure 5, with each bag spanning at least four fuselage frame or bulkhead stations.

SHORING

1. General

Shoring is used during primary structural repairs and when other means of supporting the airplane are not practical. Shoring fixtures are placed under, and in alignment with, primary structural members such as spars, beltframes, and wing splices. Blocks placed in contact with the skin surfaces should be padded and covered with felt or rubber to eliminate the possibility of scratching or denting the airplane surfaces. These blocks should be of sufficient width to distribute the load evenly across the width of the structural member. The total weight of the airplane must be reduced to a minimum by removing fuel and other nonessential items. The engines must be removed before shoring for a major wing repair.

The airplane should be leveled before shoring is placed under it and shims should be placed under the shoring fixtures to equalize the pressure of the fixtures against the airplane. The level of the airplane should be checked after the jacks are removed and the airplane is resting completely on the shorings; leveling corrections by means of adding or removing fixture shims should be made whenever the level attitude of the airplane is impaired.

Shorings at the following support points will ensure that the fuselage and wings are in the no-load condition. The major support points for the fuselage shoring are located at fuselage stations 250, 964, and 1488. The auxiliary support points for the fuselage shoring are located in pairs at fuselage stations 306 and 326, 432 and 451, 546 and 565, 641 and 660, 1040 and 1059, 1154 and 1173, 1230 and 1249, and 1363 and 1378. The major support points for wing shorings are at the front spar, center spar, and rear spar at bulkheads 8 and 23, and at the front spar and rear spar for wing shoring at bulkhead 36.

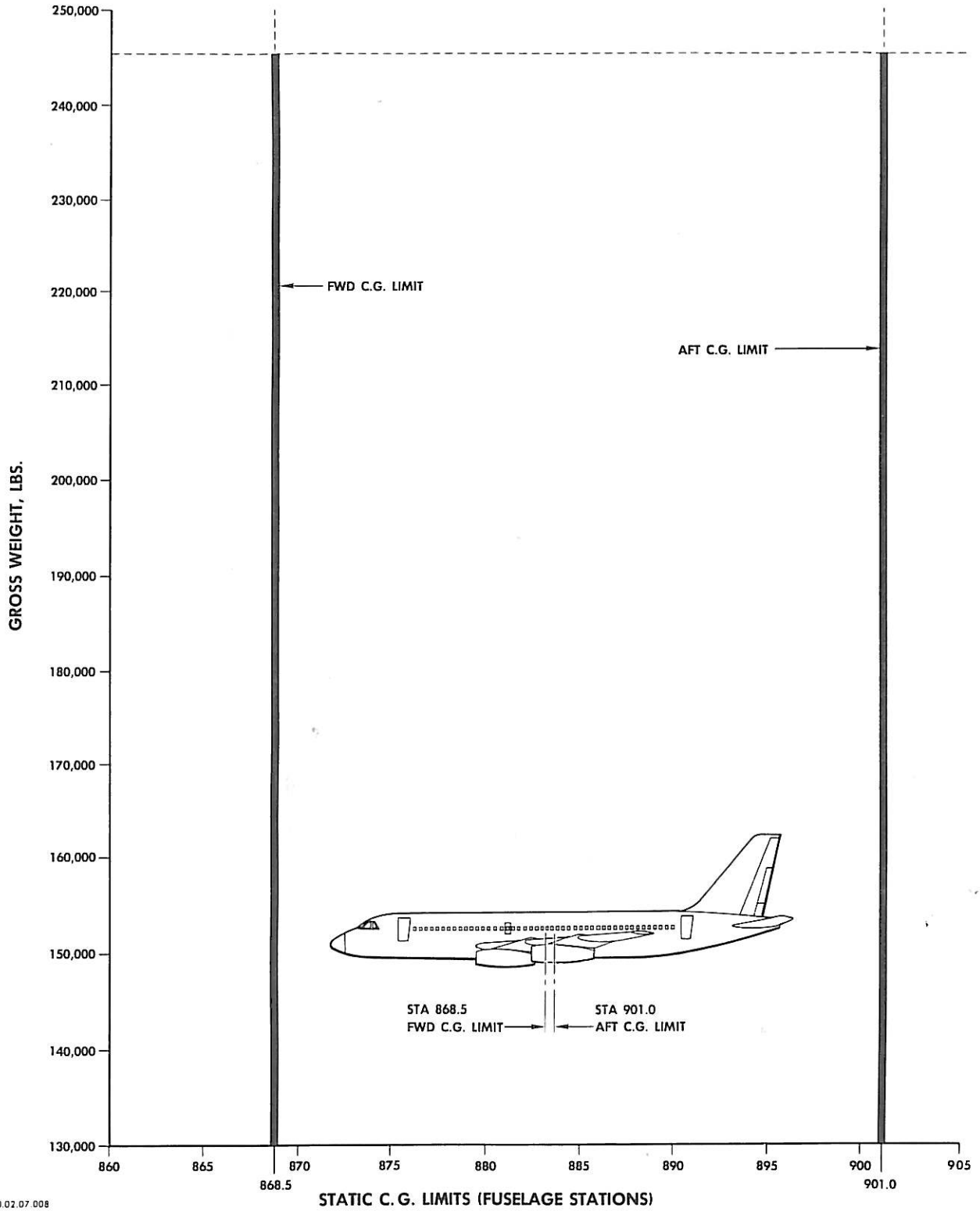
2. Center of Gravity Limitations - Static Ground Condition

Center of gravity limitations for static weights (airplane at rest on the ground) are shown on Figure 1, This information may be useful during emergency shoring operations. Shoring placed underneath the airplane must include supports at points well outside of the center of gravity limits.

3. Construction and Placement of Wooden Shoring

The construction and placement of wooden shoring fixtures for the fuselage and wings are shown on Figures 2 and 3.

AIRCRAFT WEIGHT, LBS.



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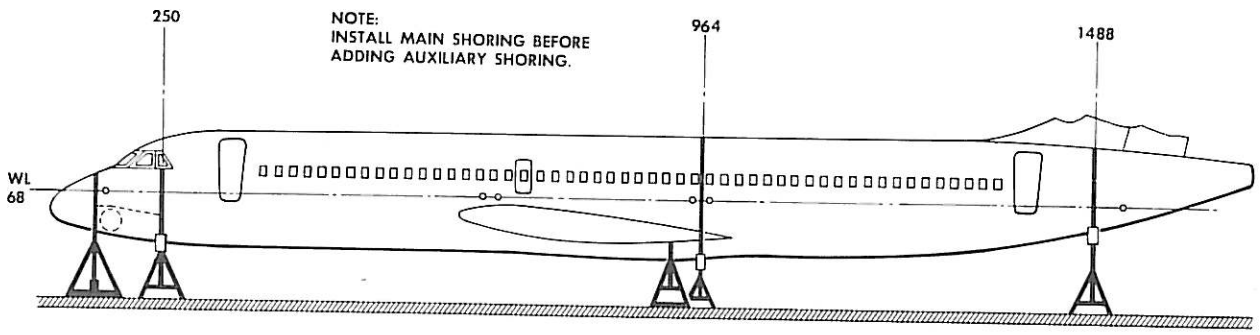
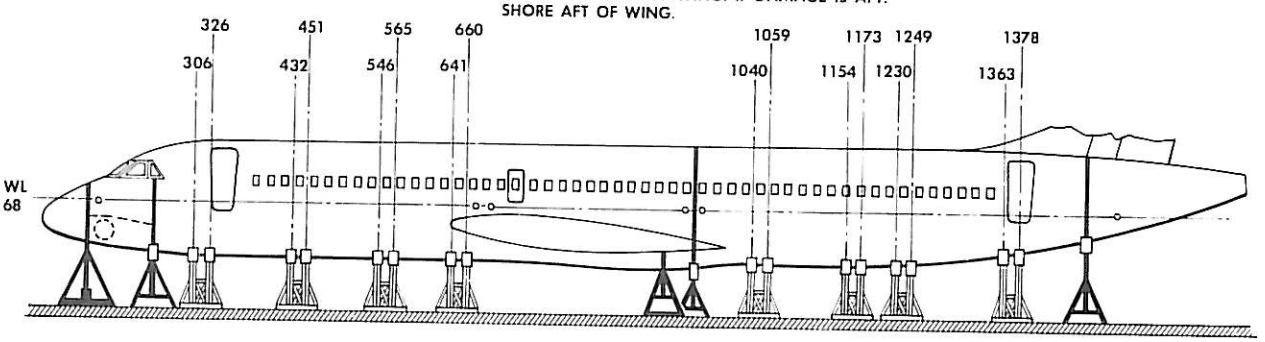
Center of Gravity Limitations -
Static Ground Condition
Figure 1

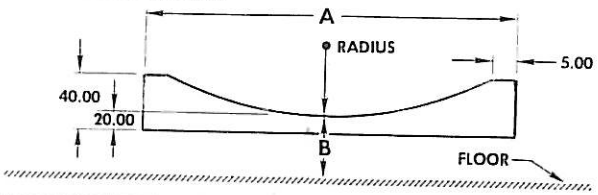


MAIN WOODEN SHORINGS



AUXILIARY WOODEN SHORINGS

NOTE:
PROVIDE CUTOUT FOR LONGERON
KEEL WHERE NECESSARY.



STA	A	B	RADIUS
250	80.00	76.142	58.92
306	80.00	72.707	64.08
326	80.00	72.144	64.80
432	80.00	71.937	65.05
451	80.00	71.937	65.05
546	80.00	71.937	65.05
565	80.00	71.937	65.05
641	80.00	71.937	65.05
660	50.00	71.937	65.05
1040	80.00	71.937	65.05
1059	80.00	71.937	65.05
1154	80.00	71.937	65.05
1173	80.00	71.937	65.05
1230	80.00	72.832	65.05
1249	80.00	73.572	65.05
1363	80.00	83.882	65.55
1378	80.00	86.027	66.00
1488	70.00	107.055	58.00

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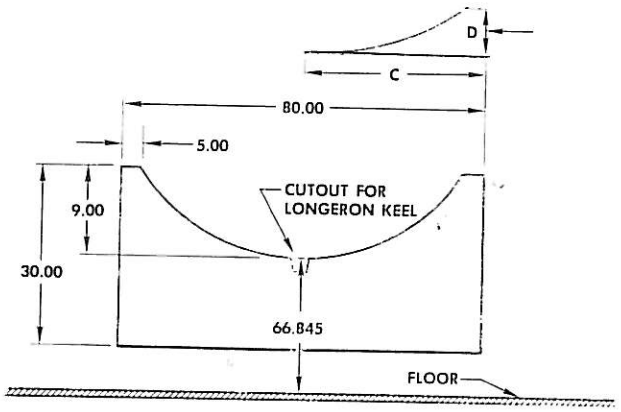
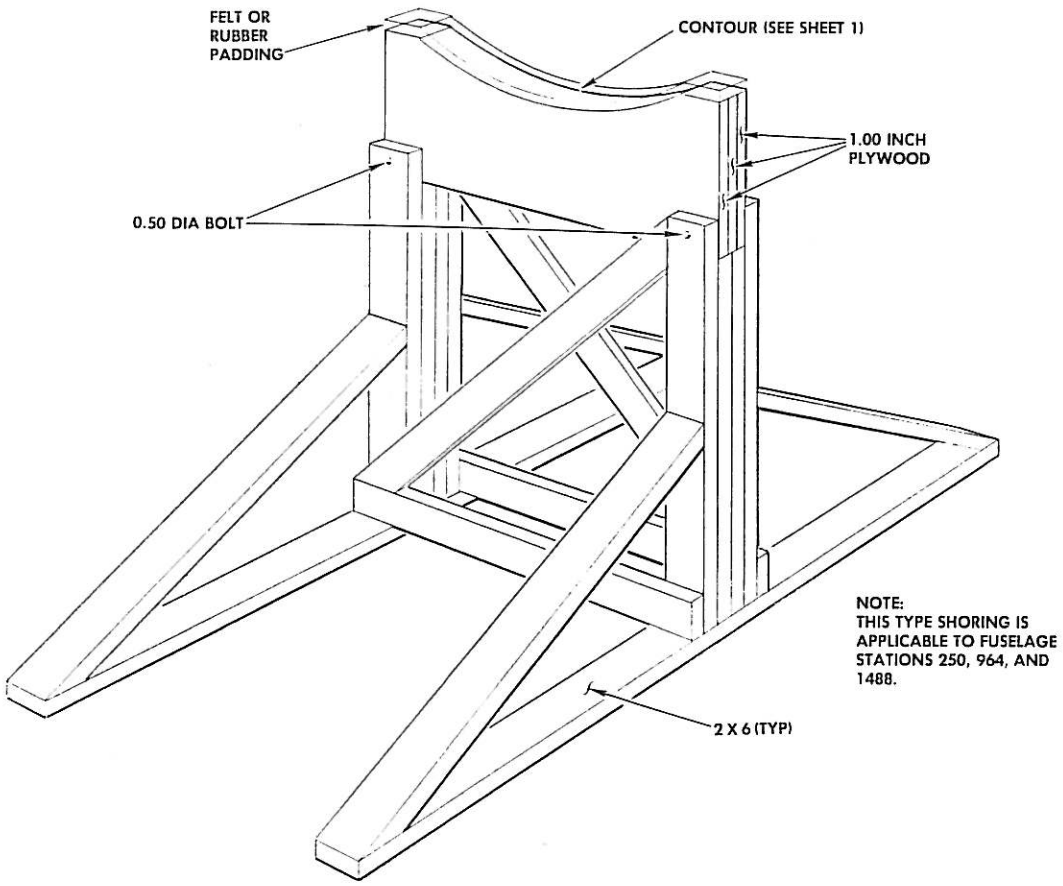
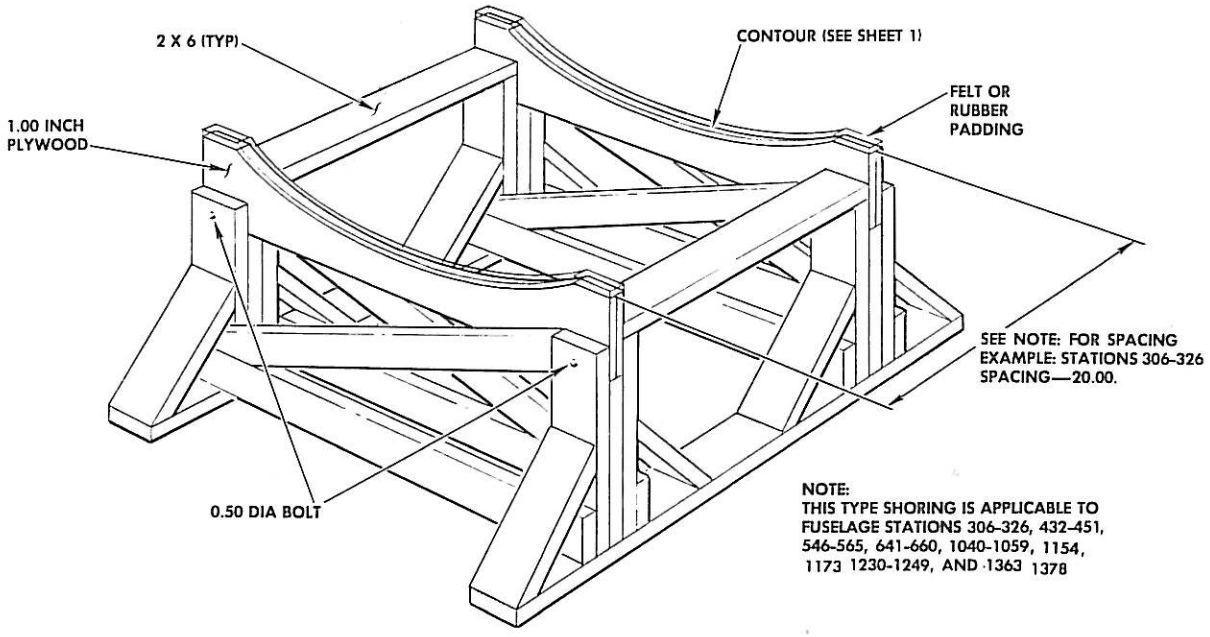
C	0	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00
D	0	0.00	0.08	0.42	1.10	2.22	3.83	6.08	9.16



STATION 964

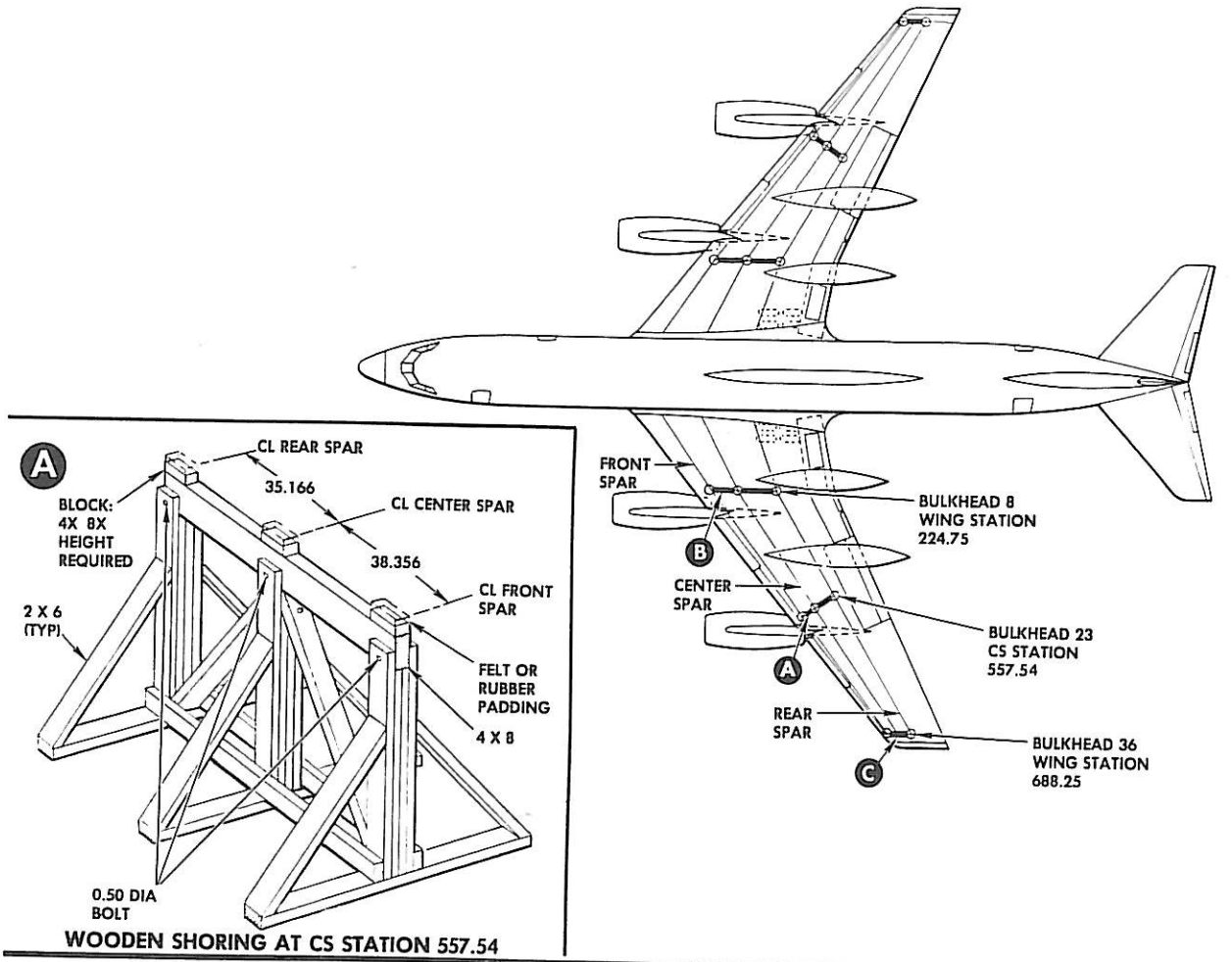


TYPICAL MAIN WOODEN SHORING

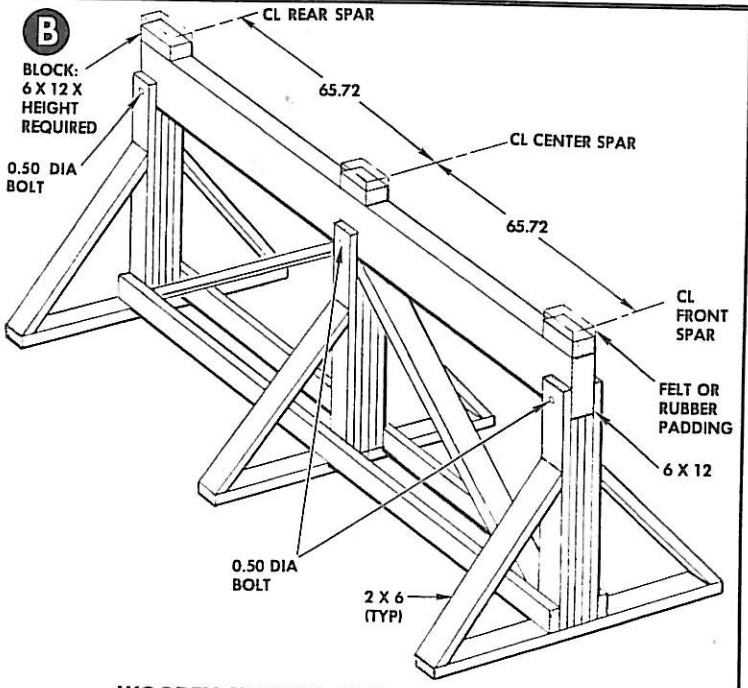


TYPICAL AUXILIARY WOODEN SHORING

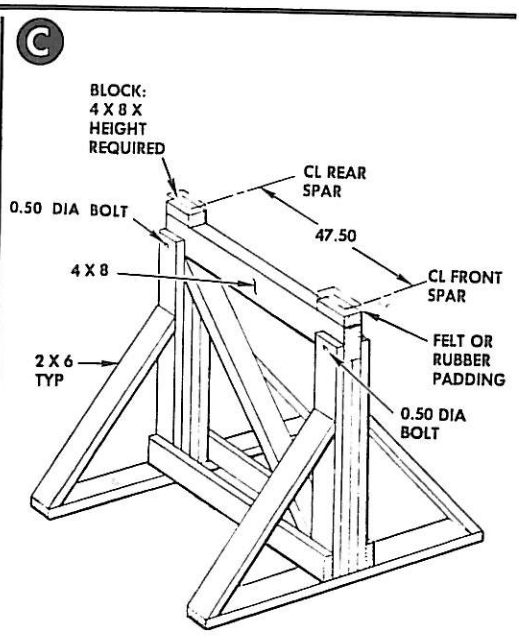
M
30.02.07.009-2



WOODEN SHORING AT CS STATION 557.54

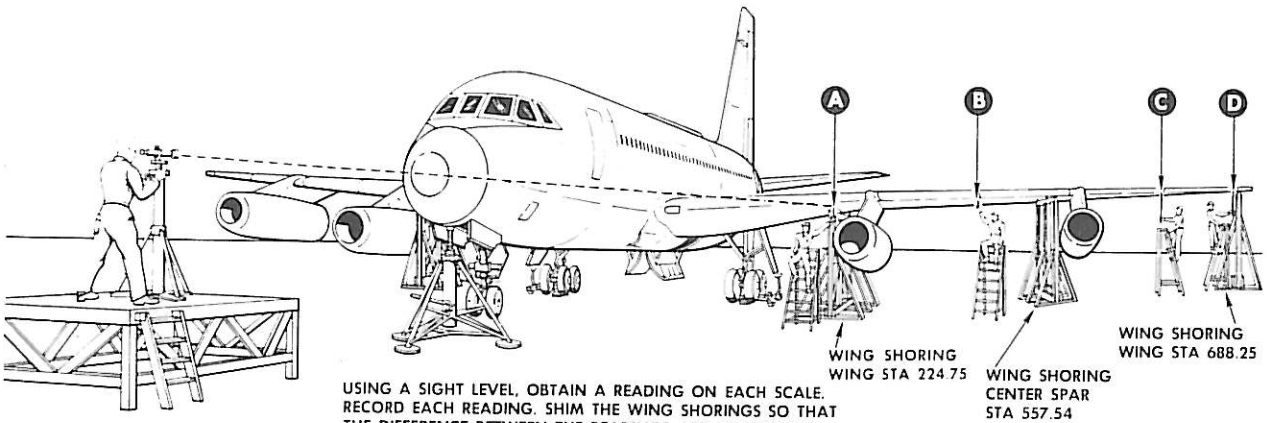


WOODEN SHORING AT WING STATION 224.75



WOODEN SHORING AT WING STATION 688.25

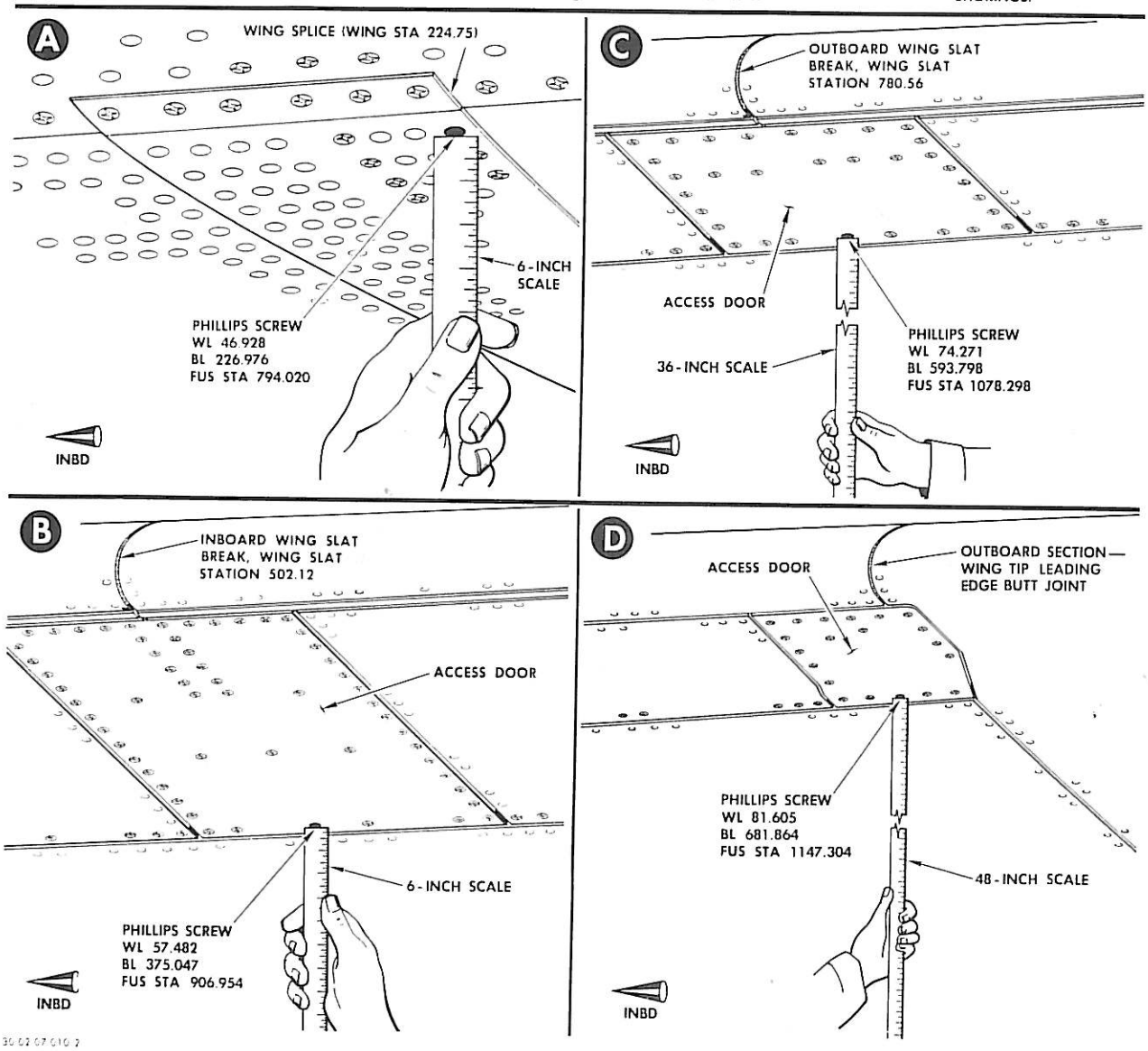
30.02.07.010-1



USING A SIGHT LEVEL, OBTAIN A READING ON EACH SCALE. RECORD EACH READING. SHIM THE WING SHORINGS SO THAT THE DIFFERENCE BETWEEN THE READINGS ARE AS FOLLOWS:

1. VIEW (B) READING MINUS VIEW (A) READING= 10.55 INCHES.
2. VIEW (C) READING MINUS VIEW (B) READING=16.79 INCHES.
3. VIEW (D) READING MINUS VIEW (C) READING= 7.33 INCHES.

NOTE:
SEE SHEET 1 FOR CONSTRUCTION AND LOCATION OF WING SHORINGS.



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Construction and Placement of Wing Wooden Shorings
Figure 3 (Sheet 2 of 2)

Chapter 8
LEVELING AND WEIGHING

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CHAPTER 8

LEVELING AND WEIGHING - DESCRIPTION AND OPERATION

1. General

Leveling and weighing procedures are utilized by maintenance and engineering personnel during repairs, replacement, installation, servicing, periodic weighing to determine weight growth and relocate the center of gravity, and the like. Design of the airplane includes provisions for leveling. These provisions are readily accessible and, when used in conjunction with the required ground support equipment such as jacks, scales, levels, and the like, enable leveling and weighing operations to be accomplished quickly and properly.

LEVELING - DESCRIPTION AND OPERATION

1. General

Airplane leveling is required for weighing, center of gravity determination, alignment checks, fuel tank calibrations, major structural repairs, and the like. For some occasions inflating or deflating the critical landing gear oleo strut is sufficient to obtain a level attitude. Usually, however, the leveling is accomplished by adjusting the extension of the jacks installed under the airframe jack points. Whenever lateral leveling is to be done it should be completed before the longitudinal leveling, otherwise the obtained longitudinal level may be disturbed by the lateral leveling process. The airplane is provided with installations for both lateral and longitudinal leveling with either a spirit level placed on leveling lugs, or a plumb bob and line suspended over an indicator scale.

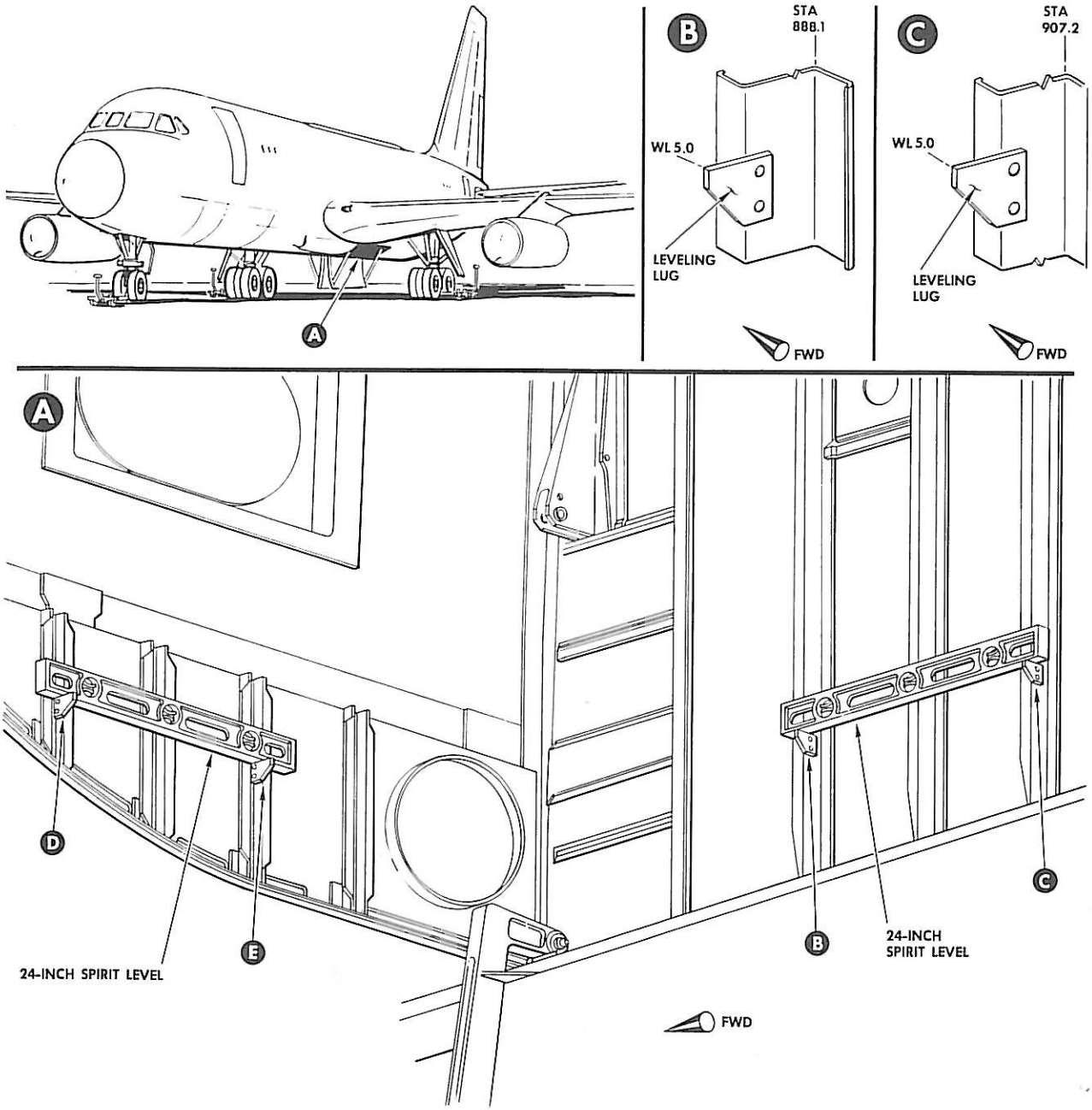
Alternate methods for leveling may be accomplished by using a sight level and predetermined reference points (rivet heads at water line 68) located along the outer surfaces of each side of the fuselage, and at common points on the lower surface of each wing. Longitudinal leveling only may also be accomplished by using a sight level and tooled depressions in the external keel longeron. An alternate method for both lateral and longitudinal leveling may also be accomplished by the water hose method, using predetermined reference points (the leveling depressions in the external keel longeron) and common points on the lower surface of each wing.

2. Leveling With a Spirit Level on Wheel Well Leveling Lugs

Provisions for lateral and longitudinal leveling are installed in the left main landing gear wheel well, as shown on Figure 1. The lateral leveling lugs are located on the lower forward bulkhead stiffeners in the left main wheel well, along WL 3.5. The longitudinal leveling lugs are located on lower portions of stiffeners of the centerline web that separates the wheel wells, on the left side along WL 5.0. A 24-inch spirit level is placed directly on the leveling lugs to accomplish the leveling desired.

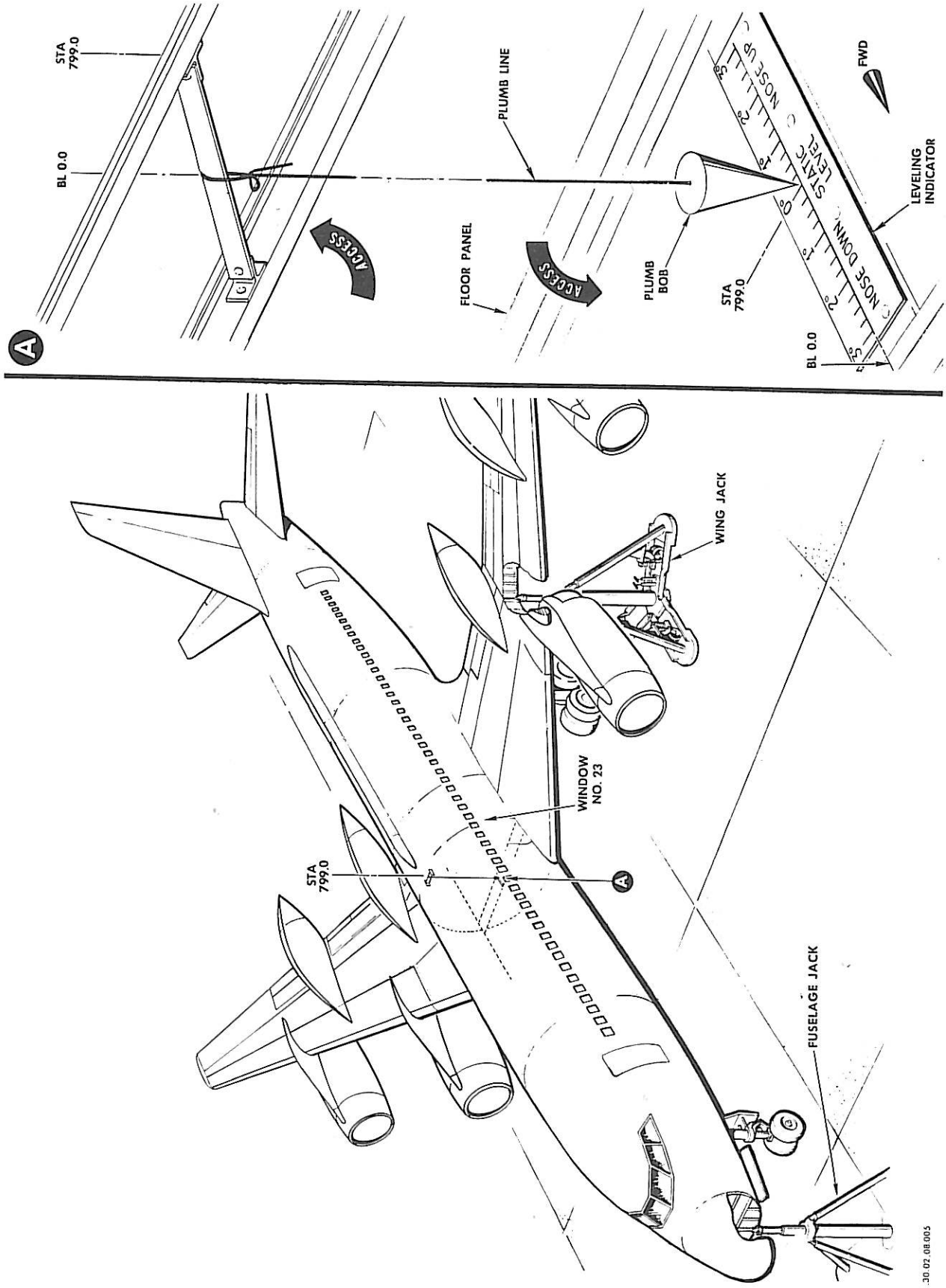
3. Leveling With a Plumb Bob and Line

Provisions for lateral and longitudinal leveling with a plumb bob and line are installed inside the cabin at fuselage station 799.0, as shown on Figure 2. A notched transverse member is provided for plumb line suspension. It is located inside the cabin ceiling trim near WL 148 and is centered on BL 0.0. A level indicator scale is installed on the center floor beam top surface on WL 58.38 and is centered on BL 0.0. Removing pertinent ceiling and floor panels provides access to the notched transverse member and the leveling indicator scale. When both a lateral and longitudinal level attitude are obtained, the plumb bob point will be directly above both the BL 0.0 line and the zero degree reference point on the indicator scale.



NOTES:
1. LEVEL AIRPLANE LATERALLY BY ADJUSTING MAIN LANDING GEAR JACK EXTENSIONS UNTIL MOVABLE BUBBLE IS CENTERED.
2. LEVEL AIRPLANE LONGITUDINALLY BY ADJUSTING NOSE LANDING GEAR JACK EXTENSION UNTIL MOVABLE BUBBLE IS CENTERED.

LEFT MAIN WHEEL WELL



Leveling With a Plumb Bob and Line
Figure 2

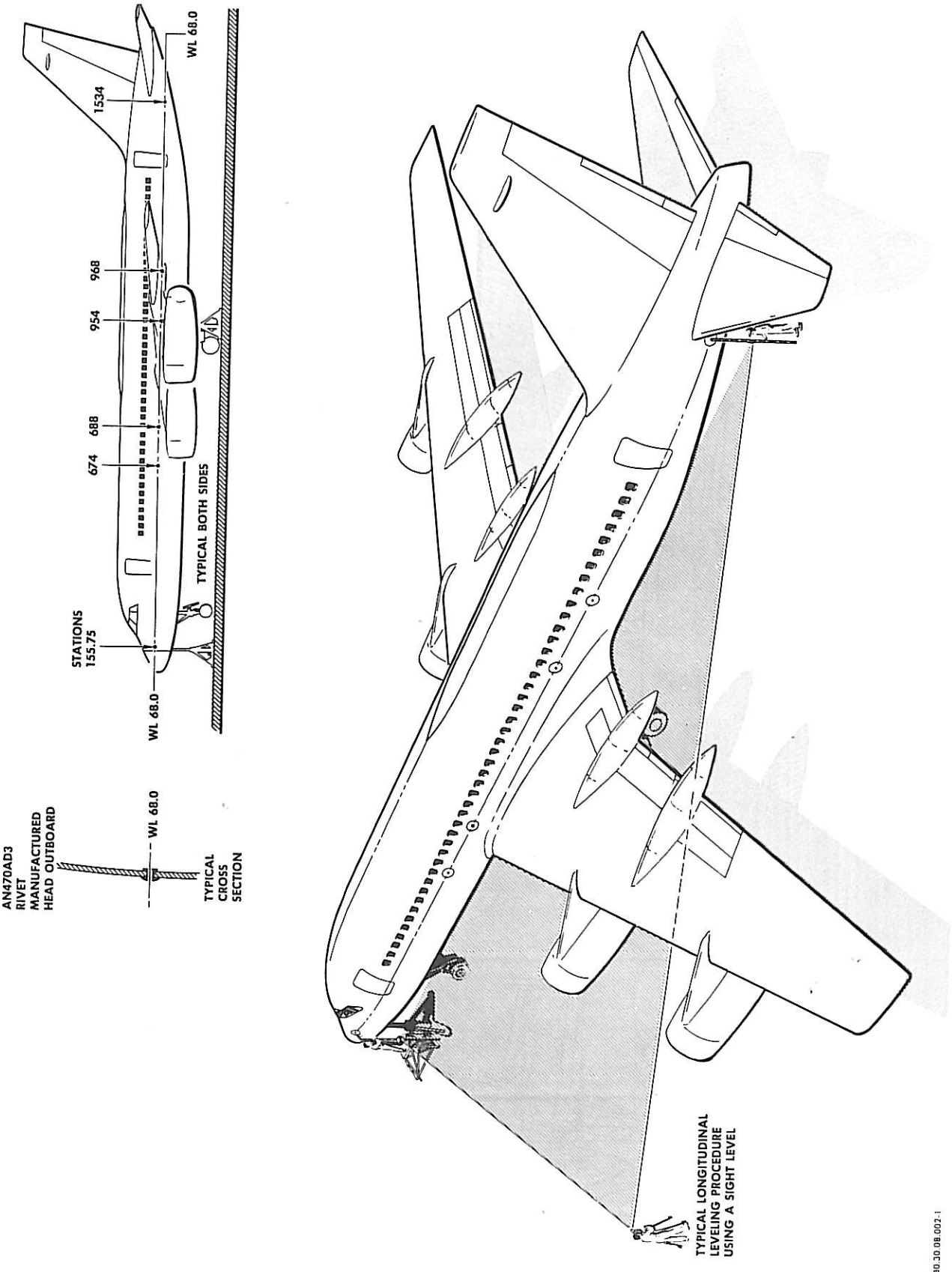
4. Leveling With a Sight Level

Six AN470AD3 rivets (with manufactured head outboard) are driven on each side of the fuselage at stations 155.75, 674, 688, 954, 968, and 1534 along WL 68, to be used as longitudinal reference points when using a sight level to obtain airplane level attitude. When using a sight level on these rivets, the airplane must be in an area where ambient temperatures are nearly the same on all surfaces in order to prevent distorted readings. By using a scale with a movable indication point, the sight level can be positioned at a point lower than the rivets, as shown on Figure 3. This method is much faster than attempting to align the sight level on a horizontal plane with the reference point. Lateral leveling is accomplished in the same manner, using a sight level to obtain readings on a scale held at a common point on the lower surface of each wing.

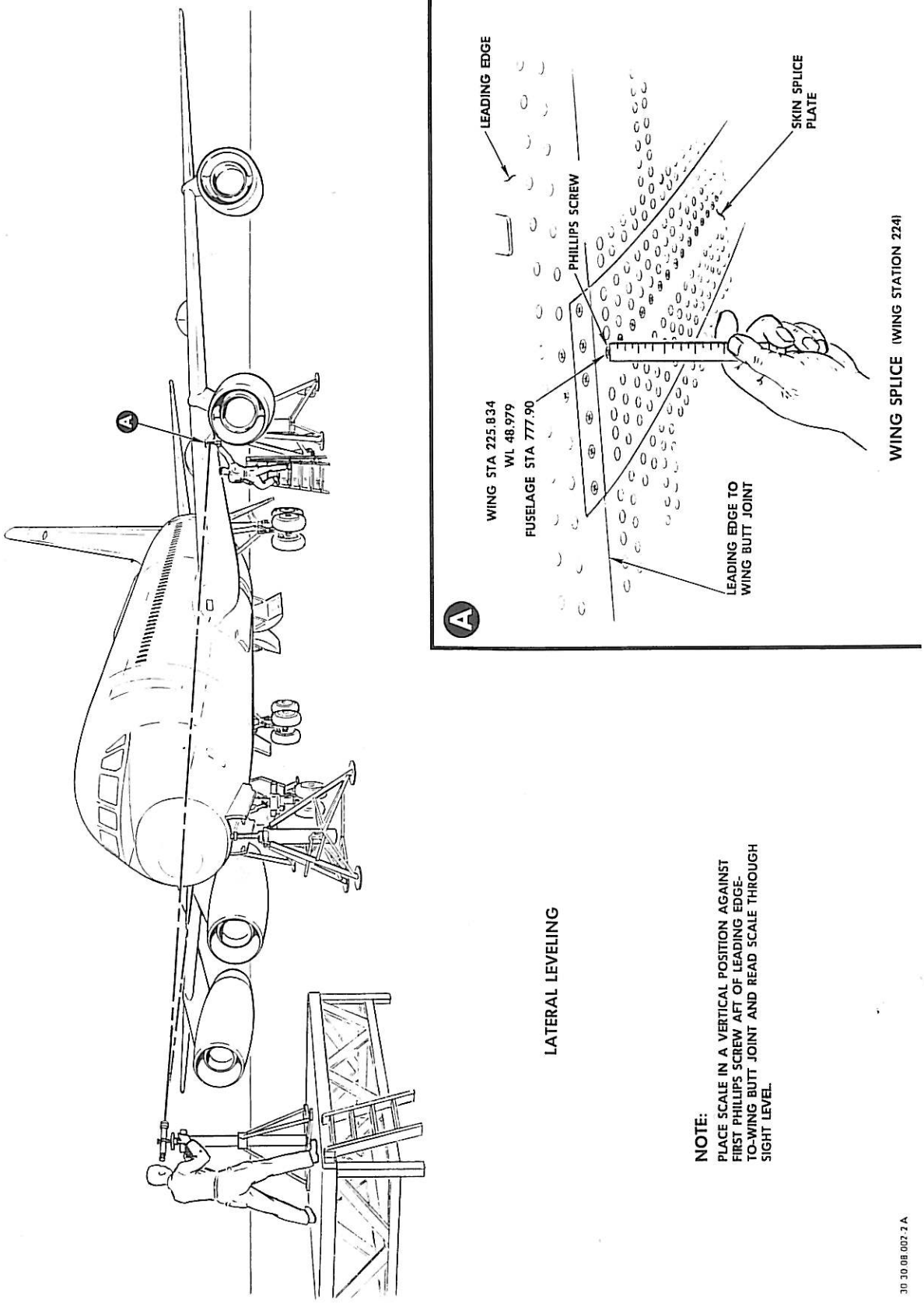
Two depressions for sighting when leveling the airplane longitudinally are drilled in the right side of the external longeron keel on WL -2.0 at fuselage stations 603.0 and 1042.0. These depressions may be used for longitudinal reference points when leveling with a sight level, as shown on Figure 4.

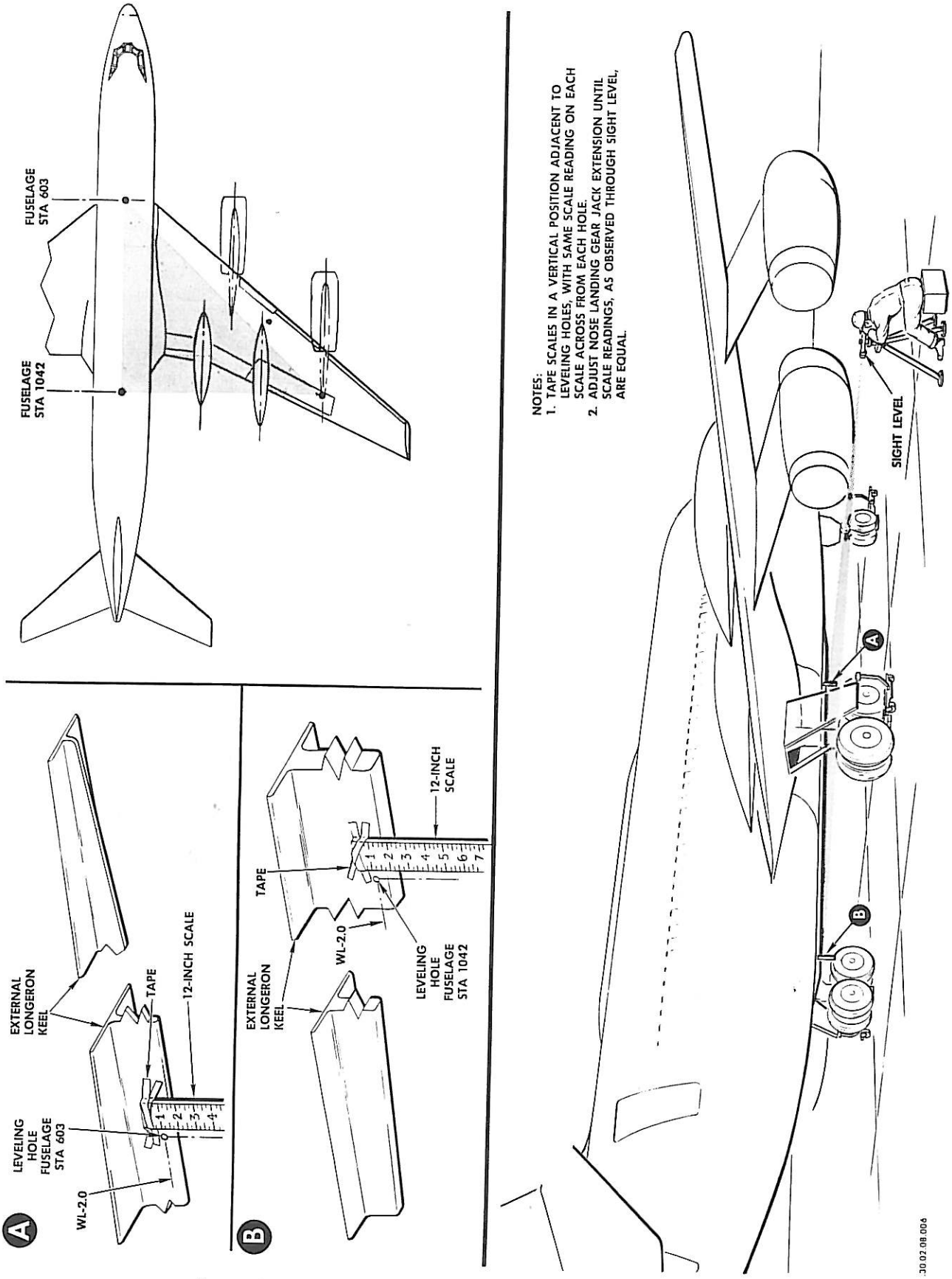
5. Leveling With a Transparent Water Hose

A 50-foot transparent water hose nearly filled with water may be used to level the airplane both laterally and longitudinally, as shown on Figure 5. Common points on the lower surface of each wing, such as the threaded holes for the screws just aft of the leading edge to wing butt joint at wing station 225.834, may be used for attaching the scales and hose for lateral leveling. The depressions for sight leveling on WL -2.0 in the external longeron keel may be used for reference points for longitudinal leveling. Since water seeks its own level this method is both simple and accurate.



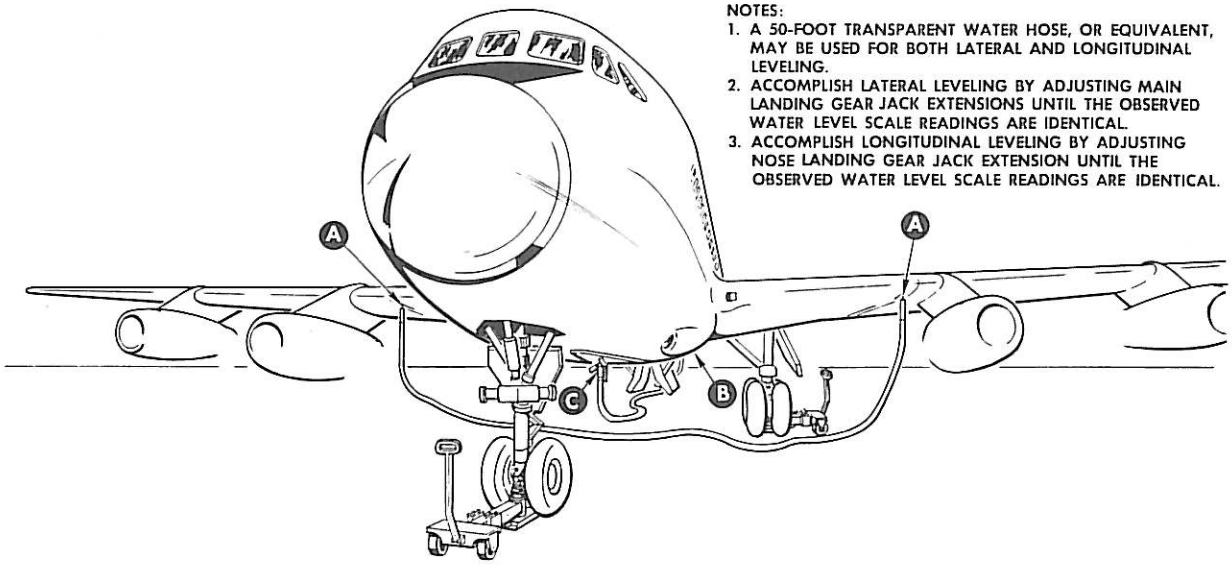
Leveling With a Sight Level
Figure 3 (Sheet 1 of 2)

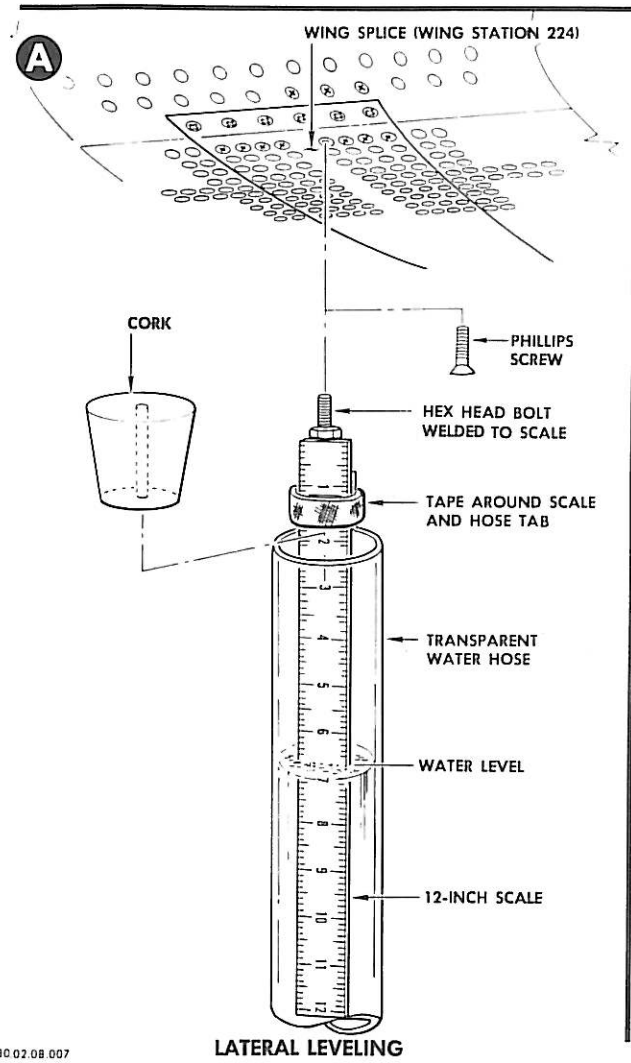

A
LEADING EDGE
PHILLIPS SCREW
SKIN SPLICE PLATE
WING STA 225.834
WL 48.979
FUSELAGE STA 777.90
LEADING EDGE TO WING BUTT JOINT
WING SPLICE (WING STATION 224)
LATERAL LEVELING
NOTE:
PLACE SCALE IN A VERTICAL POSITION AGAINST FIRST PHILLIPS SCREW AFT OF LEADING EDGE-TO-WING BUTT JOINT AND READ SCALE THROUGH SIGHT LEVEL.
30 30 08 002 2 A



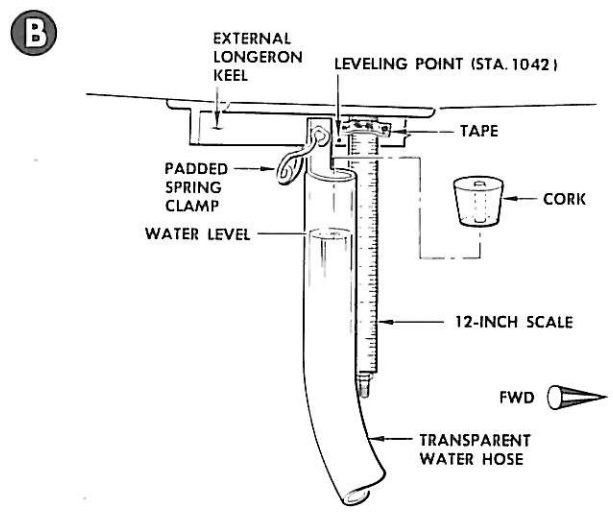
Longitudinal Leveling With Sight Level and Reference Points on External Longeron Keel
Figure 4

NOTES:
1. A 50-FOOT TRANSPARENT WATER HOSE, OR EQUIVALENT, MAY BE USED FOR BOTH LATERAL AND LONGITUDINAL LEVELING.
2. ACCOMPLISH LATERAL LEVELING BY ADJUSTING MAIN LANDING GEAR JACK EXTENSIONS UNTIL THE OBSERVED WATER LEVEL SCALE READINGS ARE IDENTICAL.
3. ACCOMPLISH LONGITUDINAL LEVELING BY ADJUSTING NOSE LANDING GEAR JACK EXTENSION UNTIL THE OBSERVED WATER LEVEL SCALE READINGS ARE IDENTICAL.

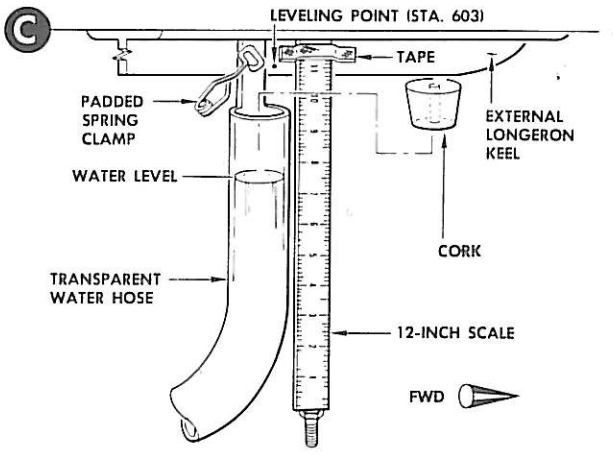




LATERAL LEVELING



LONGITUDINAL LEVELING



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Leveling With Transparent Water Hose
Figure 5

LEVELING - MAINTENANCE PRACTICES

1. Leveling With a Spirit Level on Wheel Well Leveling Lugs

A. Equipment Required.

NOTE: The following equipment is required in addition to that listed in Chapter 7, LIFTING AND SHORING, for jacking procedure:

(1) 24-inch spirit level.

NOTE: This spirit level must be of good quality and of verified accuracy.

B. Preparation.

(1) Move the airplane onto the most level surface available. Prepare airplane for jacking. Refer to Chapter 7, LIFTING AND SHORING, for instructions.

(2) Place the jacks under the airplane and jack until all landing gear tires clear the ground by one inch. Refer to Chapter 7, LIFTING AND SHORING, for instructions.

C. Airplane Leveling.

(1) Place 24-inch spirit level on lateral leveling lugs in left main wheel well, as shown on Figure 1.

(2) Adjust main landing gear jack extension until the movable bubble is centered on the spirit level.

(3) Place 24-inch spirit level on longitudinal leveling lugs in left main wheel well, as shown on Figure 1.

(4) Adjust nose landing gear jack extension until the movable bubble is centered on the spirit level.

(5) Recheck lateral level by repeating step (1).

CAUTION: IF STEP (5) DISCLOSES NEED TO REPEAT STEP (2), STEPS (3), (4), AND (5) MUST ALSO BE REPEATED.

2. Leveling With a Plumb Bob and Line

A. Equipment Required.

NOTE: The following equipment is required in addition to that listed in Chapter 7, LIFTING AND SHORING, for jacking procedure:

(1) Plumb bob, with eight-foot plumbline.

B. Preparation.

(1) Move the airplane onto the most level surface available. Prepare airplane for jacking. Refer to Chapter 7, LIFTING AND SHORING, for instructions.

(2) Obtain access to plumbline notched transverse member by removing ceiling panel inside cabin at fuselage station 799. Refer to Chapter 25, EQUIPMENT/FURNISHINGS, for instructions.

(3) Obtain access to leveling indicator scale by removing carpet and cabin floor panel at fuselage station 799. Refer to Chapter 25, EQUIPMENT/FURNISHINGS, for carpet removal instructions; refer to Chapter 53, FUSELAGE, for floor panel disassembly.

(4) Suspend plumb bob and line over notched transverse member with line in front of member, slip line into centered notch, and secure line so that plumb bob point just clears leveling indicator scale.

(5) Place the jacks under the airplane and jack until all landing gear tires clear the ground by one inch. Refer to Chapter 7, LIFTING AND SHORING, for instructions.

C. Airplane Leveling.

(1) Adjust jack extensions until the plumb bob pointer is directly above both the BL 0.0 line and the zero degree reference point on the leveling indicator scale.

(2) When level attitude has been obtained, remove plumb bob and line, reinstall cabin floor as directed in Chapter 53, FUSELAGE, replace ceiling trim as directed in Chapter 25, EQUIPMENT/FURNISHINGS, and relay carpet.

3. Leveling With a Sight Level

A. Equipment Required.

NOTE: The following equipment is required in addition to that listed in Chapter 7, LIFTING AND SHORING, for jacking procedure:

(1) Instrument stand (Keuffel & Esser No. 9092 or equivalent) or tripod that supports sight level at eye level of standing man.

(2) Sight level (Keuffel & Esser No. P-5022 or equivalent).

(3) Metal scale (Keuffel & Esser No. 9099, six foot, or equivalent) or surveyors scale with movable indicator.

(4) Two 12-inch scales.

B. Preparation.

(1) Move the airplane onto the most level surface available. Prepare airplane for jacking. Refer to Chapter 7, LIFTING AND SHORING, for instructions.

(2) Place the jacks under the airplane and jack until all landing gear tires clear the ground by one inch. Refer to Chapter 7, LIFTING AND SHORING, for instructions.

(3) Place a sight level, mounted on an instrument stand or tripod, on ground about 20 feet forward of airplane.

(4) Aim sight level at wing bulkhead 8 and level slight level to obtain level line of sight as indicated by split bubble on the instrument.

C. Airplane Leveling.

(1) Place man with 12-inch scale in front of each wing bulkhead 8.

(2) With 12-inch scale held at a common point on each wing, such as screw just aft of leading edge to wing butt joint at wing station 225.834 (see Sheet 2 of Figure 3), align sight level cross hairs on one 12-inch scale and record observed reading.

(3) Swing sight level to other 12-inch scale, check or reset level of sight level, align sight level, and record observed reading.

(4) Compare observed scale readings and raise or lower one wing jack until readings are identical when observed through sight level.

(5) Move sight level to either side of airplane to a location about 60 feet from and in line with fifth window aft of emergency door.

(6) Place man, as shown on Figure 3, with six-foot metal scale, or surveyors scale with movable indicator, at fuselage station 115.75 and check or reset level of sight level when aimed at scale. With top end of scale held on protruding AN470AD3 rivet head at WL 68.0, align sight level cross hairs on scale and record observed reading.

(7) Move scale to fuselage station 1534 and check or reset level of sight level when aimed at scale. With top end of scale held on protruding AN470AD3 rivet head at WL 68.0, align sight level cross hairs on scale and record observed reading.

(8) Compare observed scale readings and raise or lower fuselage nose jack until readings are identical when observed through sight level.

4. Longitudinal Leveling With Sight Level and External Longeron Keel References

A. Equipment Required.

NOTE: The following equipment is required in addition to that listed in Chapter 7, LIFTING AND SHORING, for jacking procedure:

(1) Instrument stand (Keuffel & Esser No. 9092 or equivalent) or tripod that supports sight level at eye level of sitting man.

(2) Sight level (Keuffel & Esser No. P-5022 or equivalent).

(3) Two 12-inch scales.

B. Preparation.

(1) Move the airplane onto the most level surface available. Prepare airplane for jacking. Refer to Chapter 7, LIFTING AND SHORING, for instructions.

(2) Place the jacks under the airplane and jack until all landing gear tires clear the ground by one inch. Refer to Chapter 7, LIFTING AND SHORING, for instructions.

(3) Place a sight level, mounted on an instrument stand or tripod, on ground underneath right wing trailing edge near engine pod and pylon No. 4, as shown on Figure 4.

(4) Tape 12-inch scales to external longeron keel with one-inch lines of scales aligned with WL -2.0 depressions at fuselage stations 603 and 1042, as shown on Figure 4.

(5) Aim sight level at one scale and level sight level to obtain level line of sight as indicated by split bubble on the instrument.

C. Airplane Leveling.

(1) Align sight level cross hairs on one 12-inch scale and record observed reading.

(2) Swing sight level to other 12-inch scale, check or reset level of sight level, align sight level, and record observed reading.

(3) Compare observed scale readings and raise or lower fuselage nose jack until readings are identical when observed through sight level.

5. Leveling With a Transparent Water Hose

A. Equipment Required.

NOTE: The following equipment is required in addition to that listed in Chapter 7, LIFTING AND SHORING, for jacking procedure:

(1) 50-foot transparent water hose, or equivalent.

(2) Two 12-inch scales.

(3) Two AN3-14A hex head bolts (1032 NF-3A, 1-17/32 inches long).

(4) Two corks of size required to plug ends of water hose.

(5) Two padded spring clamps of clamping strength required to hold water hose to external longeron keel.

B. Preparation.

(1) Move the airplane onto the most level surface available. Prepare airplane for jacking. Refer to Chapter 7, LIFTING AND SHORING, for instructions.

(2) Place the jacks under the airplane and jack until all landing gear tires clear the ground by one inch. Refer to Chapter 7, LIFTING AND SHORING, for instructions.

(3) Remove screw aft of leading edge to wing butt joint at wing station 225.834 near each wing bulkhead 8.

(4) Compare length of screws removed with length of AN3-14A hex head bolts to make sure that bolts are approximately 1/8 inch shorter than screws removed.

(5) Insert bolts (by hand) in screw holes to make sure that threads match; tag and bag screws when bolt suitability has been established.

(6) Weld AN3-14A hex head bolt (or bolt of established suitability) to zero end of each 12-inch scale.

(7) Drill small relief hole through center of each cork.

(8) Cut away portion of each water hose end to provide tabs similar to those shown on Figure 5.

(9) Fill water hose with pressurized water, allowing water to flow through until all air bubbles are expelled from hose.

(10) Cork each hose end to prevent water loss while handling hose.

(11) Install scales under wings, turning each bolt same number of turns.

(12) Tape scales to each tab end of filled water hose, as shown on Figure 5, making sure that portion of filled hose lies on ground.

C. Airplane Leveling.

(1) Remove corks from ends of filled water hose, allowing time for water to stabilize before observing water level readings.

(2) Level airplane laterally by raising or lowering one wing jack until water level readings are identical, allowing time for water to stabilize after each jacking operation.

(3) Remove tapes and water hose from scales and cork each hose end.

(4) Remove scales under wings and replace proper screws in holes used.

(5) Tape 12-inch scales, with hex head bolts downward, to external longeron keel with one-inch lines of scales aligned with WL -2.0 depressions at fuselage stations 603 and 1042, as shown on Figure 5.

(6) Clamp ends of filled water hose next to scales with padded spring clamps, as shown on Figure 5, making sure that portion of filled hose lies on ground.

(7) Remove corks from ends of filled water hose, allowing time for water to stabilize before observing water level readings.

(8) Level airplane longitudinally by raising or lowering fuselage nose jack until water level readings are identical, allowing time for water to stabilize after each jacking operation.

(9) Cork each hose end and remove padded clamps, water hose, tapes, and scales from external longeron keel.

WEIGHING - DESCRIPTION AND OPERATION

1. General

The basic weight of the airplane is that weight which includes all fixed operating equipment and trapped fuel and oil, to which it is necessary to add variable, expendable, and special load items. Basic weight plus the variable items which remain constant for a specified flight operation and which include oil, crew, and emergency equipment, is known as operating weight. Gross weight is the total weight of the airplane; it is the operating weight plus all variable, expendable, and special load items.

Weighing can be accomplished by utilizing flush platform scales, or by using electronic weighing cells in conjunction with hydraulic jacks. The method used is dependent upon the equipment available. The following conditions should be verified before scale readings are recorded for an airplane weighing:

A. Jacking preparations completed; refer to Chapter 7, LIFTING AND SHORING.

B. Proper equipment installed in the airplane or accounted for in weighing records.

C. All airplane doors, panels, cowlings, and surfaces closed, in gear down configuration, in place or in neutral position.

D. Airplane sheltered from winds and air conditioning equipment shut off in building.

E. All wheel brakes released.

F. Airplane leveled.

2. Weighing on Flush Platform Scales

When the airplane is to be weighed on flush platform scales it must be towed into position by a tug. After spotting the airplane properly on the scales, the nose gear steering unit and wheel should be placed in a normal zero angle trailing position and the wheel brakes should be released to prevent the scales from binding. The airplane should be leveled by adjusting the extension of the landing gear shock struts as required. The as-weighed weight of the airplane is determined by totalling all three scale readings.

3. Weighing With Electronic Load Cells at the Landing Gear Strut Jack Points

A jack pad is located on the lower end of the nose landing gear strut, below the anti-skid mechanism. The maximum jacking load permitted at this jack point is 20,700 pounds. There are three jack points on each main landing gear; one on the strut centerline and under the center of the truck axle beam and one under each wheel axle. The maximum jacking load permitted on the forward wheel axle jack point is 57,500 pounds; on the aft wheel

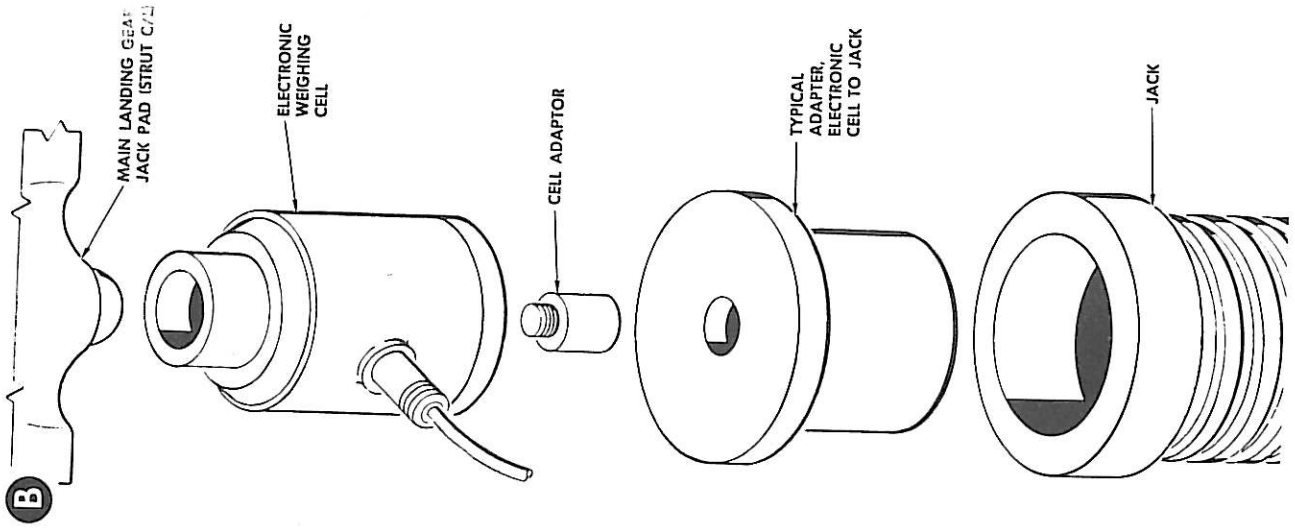
axle jack point the maximum jacking load permitted is 59,000 pounds. The maximum jacking load permitted on the center jack point is 116,500 pounds; this is the jack point used for this weighing procedure.

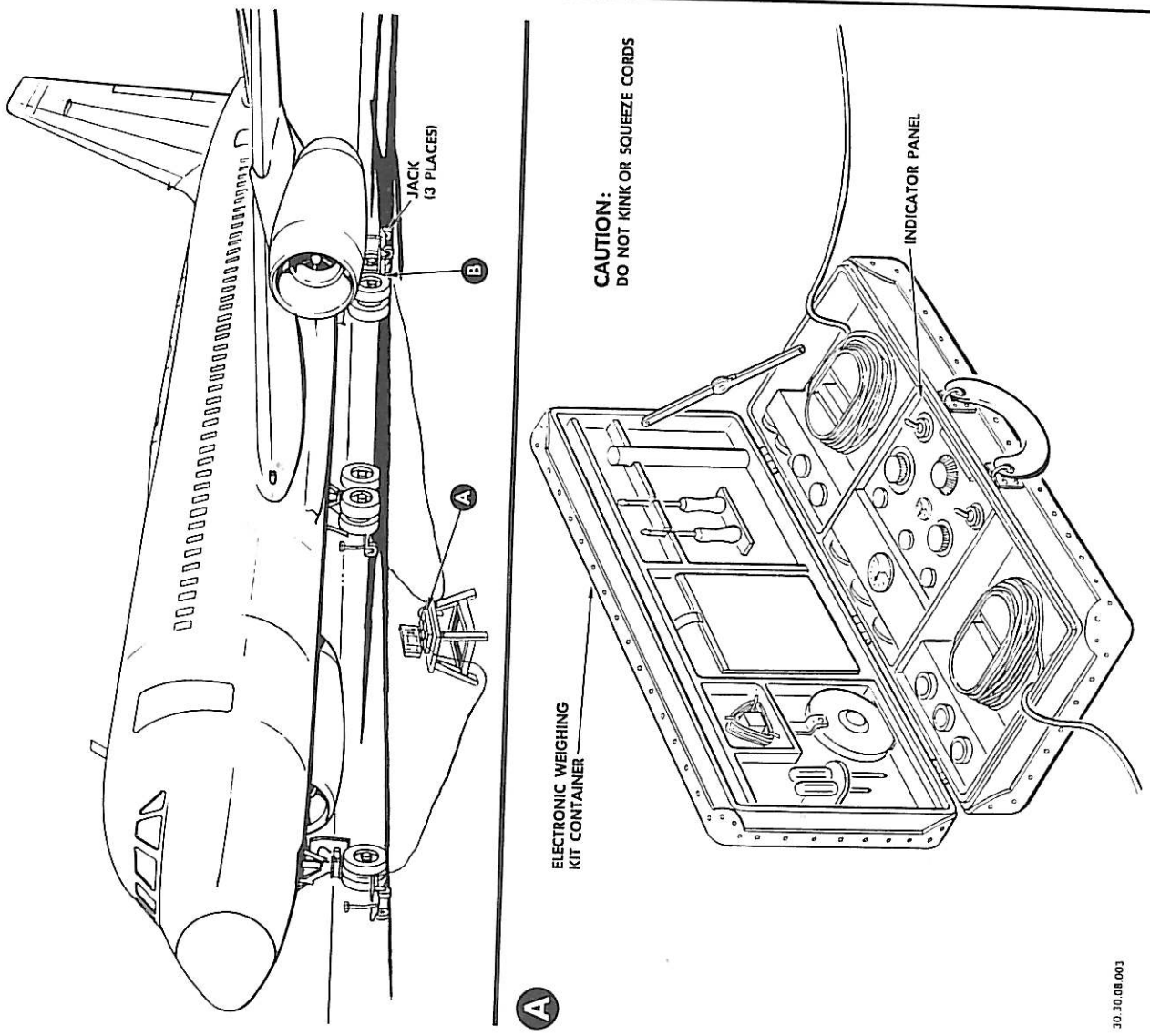
The airplane should be placed in the most level appropriate area available. Down-lock safety pins should be installed in all landing gears. The nose gear steering unit and wheel should be placed in a normal zero angle. The main landing gear truck beam should be locked by filling the positioner cylinder with oil when the beam is horizontal. The jacks, fitted with electronic load cells as shown on Figure 1, should be carefully positioned under the strut jack points and raised evenly until each landing gear tire is approximately one inch above the ground. The airplane should be leveled by adjusting the extension of the jacks as required. Weight is measured by the electronic load cells placed on the hydraulic jacks and is observed on the indicator panel of the weighing kit shown on Figure 1.

4. Weighing With Electronic Load Cells at the Structural Jack Points

There are three structural jack points on the airplane; one near the fuselage nose and one under each wing. The total maximum allowable gross weight for jacking at the fuselage and wing structural jack points is 170,400 pounds. The maximum jacking load permitted at the fuselage nose jack point is 18,400 pounds; the maximum jacking load permitted at each of the wing jack points is 85,200 pounds.

The airplane should be placed in the most level appropriate area available. Restraining clamps should be placed on each landing gear strut to prevent strut extension when the airplane is raised. The landing gear struts must be deflated prior to installing the clamps; this will prevent excessive loads from being applied on the clamps. Down-lock safety pins should be installed in all landing gears. The main landing gear truck beam should be locked by filling the positioner cylinder with oil when the beam is horizontal. The jacks, fitted with electronic load cells as shown on Figure 1, should be carefully positioned under the fuselage and wing jack points and raised evenly until each landing gear tire is approximately one inch above the ground. The airplane should be leveled by adjusting the extension of the jacks as required. Weight is measured by the electronic load cells placed on the hydraulic jacks and is observed on the indicator panel of the weighing kit shown on Figure 1.


MAIN LANDING GEAR
JACK PAD (STRUT C/L)
ELECTRONIC WEIGHING CELL
CELL ADAPTOR
TYPICAL ADAPTER, ELECTRONIC CELL TO JACK
JACK
B


JACK (3 PLACES)
B
A
CAUTION:
DO NOT KINK OR SQUEEZE CORDS
INDICATOR PANEL
ELECTRONIC WEIGHING KIT CONTAINER
30.30.08.003

WEIGHING - MAINTENANCE PRACTICES

1. Weighing With Electronic Load Cells at the Landing Gear Strut Jack Points

A. Equipment Required.

NOTE: The following equipment is required in addition to that listed in Chapter 7, LIFTING AND SHORING, for weighing the airplane at the landing gear strut jack points:

(1) Electronic Scale Weighing Kit, 300,000-pound capacity (Cox and Stevens Model CS-7B or equivalent).

B. Preparation.

(1) Move airplane onto most level surface available.

(2) Fit nose and main landing gear jacks with electronic load cells and required adapters. Follow instructions included with weighing kit.

(3) Follow Instructions and heed cautions given in Chapter 7, LIFTING AND SHORING.

(4) Position jacks, fitted with electronic load cells and adapters, carefully under nose and main landing gear strut jack points, as shown on Figure 1, and jack evenly until all landing gear tires clear ground by one inch.

(5) Level airplane laterally by either main landing gear jack, and longitudinally by raising or lowering nose landing gear jack. Verify level condition as directed in 8-1-0.

C. Airplane Weighing.

(1) Adjust pertinent weighing kit controls as directed in electronic weighing kit instructions.

(2) Record readings observed on weighing kit indicator panel for each of the three jacking points. Total the three readings to obtain as-weighed weight.

2. Weighing With Electronic Load Cells at the Structural Jack Points

A. Equipment Required.

NOTE: The following equipment is required in addition to that listed in Chapter 7, LIFTING AND SHORING, for weighing the airplane at the fuselage and wing structural jack points.

(1) Electronic Scale Weighing Kit, 300,000-pound capacity (Cox and Stevens Model CS-7B or equivalent).

B. Preparation.

(1) Move airplane onto most level surface available.

(2) Fit fuselage and wing jacks with electronic load cells and required adapters. Follow instructions included with weighing kit.

(3) Follow instructions and heed cautions given in Chapter 7, LIFTING AND SHORING.

(4) Position jacks, fitted with electronic load cells and adapters as shown on Figure 1, carefully under fuselage and wing jack pad adapters, and jack evenly until all landing gear tires clear ground by one inch.

(5) Level airplane laterally by either wing jack and longitudinally by raising or lowering fuselage nose jack. Verify level condition as directed in 8-1-0.

C. Airplane Weighing.

(1) Adjust pertinent weighing kit controls as directed in electronic weighing kit instructions.

(2) Record readings observed on weighing kit indicator panel for each of the three jacking points. Total the three readings to obtain as-weighed weight.

LIST OF EFFECTIVE PAGES

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9-0	1	Aug. 30/61	AB-1
	BLANK		
9-1-0	1	Aug. 30/61	AB-1
9-1-0	2	Aug. 30/61	AB-1
9-1-0	3	Aug. 30/61	AB-1
9-1-0	4	Aug. 30/61	AB-1
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9-2-0	1	Aug. 30/61	AB-1
9-2-0	2	Aug. 30/61	AB-1
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TOWING AND TAXIING

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Chapter 9

TOWING AND TAXIING - DESCRIPTION AND OPERATION

1. General

Towing procedures are utilized to move the airplane whenever the engines are not operating or when circumstances prohibit the noise or blast effects of operating jet engines. Towing the airplane from maintenance areas or hangars to the air terminals also represents an economy measure in fuel savings. Basic procedures used to tow other large airplanes can be adapted to towing the Convair 990. Towing is normally accomplished from the nose gear when the airplane is on hard, dry surfaces. In instances where mud, snow, or rough terrain conditions exist which create excessive towing loads, towing must be accomplished only from both main gears simultaneously. Under these conditions the forces required to move the airplane may exceed the maximum permissible towing loads at the nose landing gear. Towing from both main gears simultaneously can be accomplished in either a forward or backward direction depending on the circumstances.

Taxiing procedures can be accomplished with any number of engines, or any combination of engines operating, dependent upon the circumstances and/or operator policies. During taxiing procedures, directional control of the airplane is maintained by the use of the nose wheel steering and hydraulic brake systems. Care should be exercised to avoid endangering personnel with excessive heat or blast effects.

TOWING - DESCRIPTION AND OPERATION

1. General

Previous experience in handling large aircraft can be utilized in handling the Convair 990. Probably the only variation involved is the different equipment and possibly the location of the towing lugs on the main landing gear trucks.

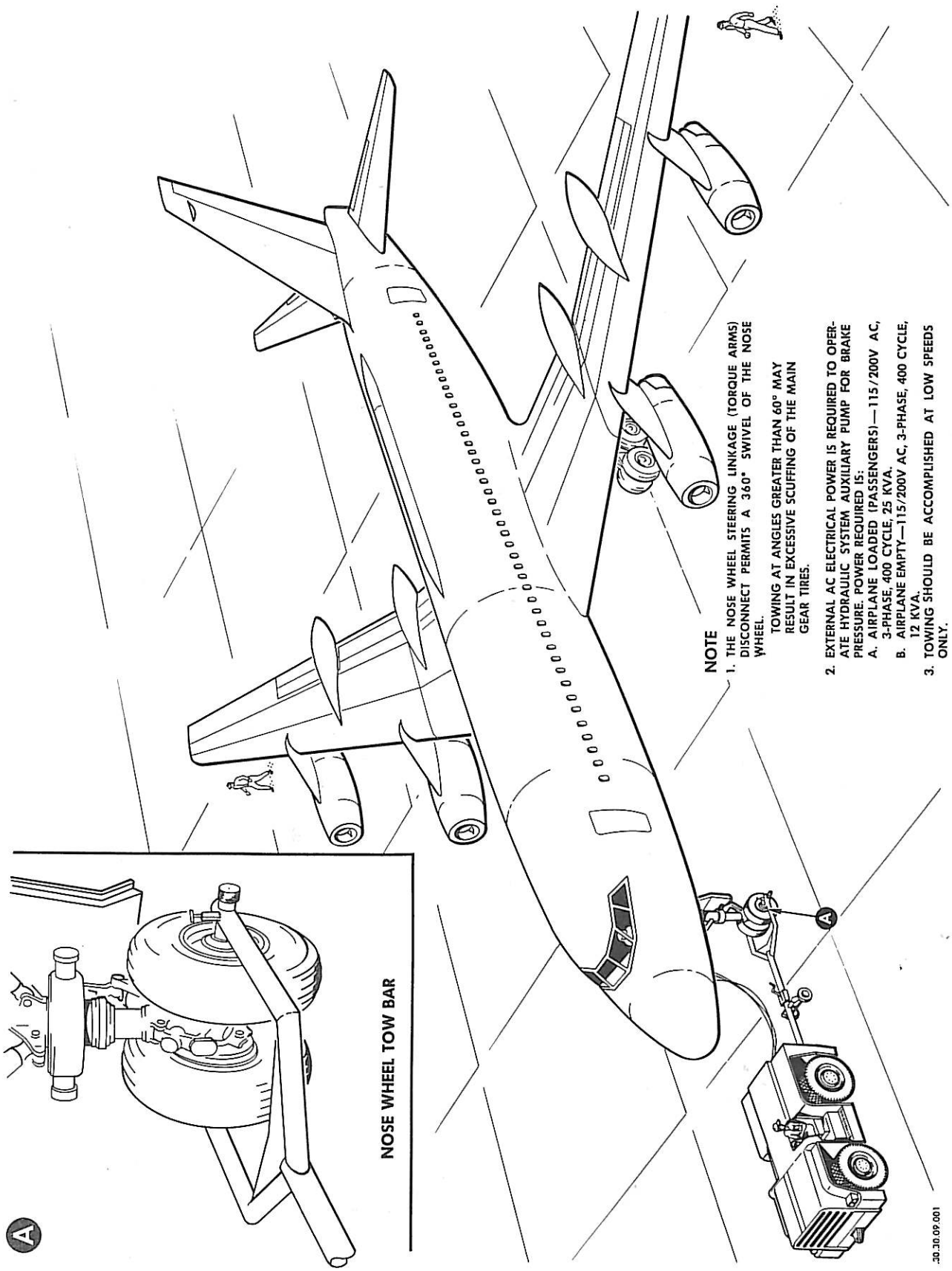
During maintenance or overhaul periods it may be necessary to tow the airplane with the engines or other heavy equipment removed. Normally, this does not create any problem during towing procedures. However, if an excessive amount of weight is removed, the subsequent shift in the airplane's center of gravity (cg) must be considered prior to towing. The airplane must never be towed when the cg is aft of station 912. When the cg has moved aft of station 912 an unsafe condition exists whereby the tail of the airplane has the tendency to tip down. An extreme condition that will result in the cg being moved aft of station 912 and will necessitate corrective action prior to towing is as follows: An airplane at empty weight (approximately 100,259 pounds), the inboard engines and flight compartment seats removed, and the electronic compartment empty of electronic gear.

To correct this condition it is necessary to install 150 pounds of ballast (evenly distributed) in the forward cargo compartment. For various permissible center of gravity configurations encountered during maintenance, refer to Table I.

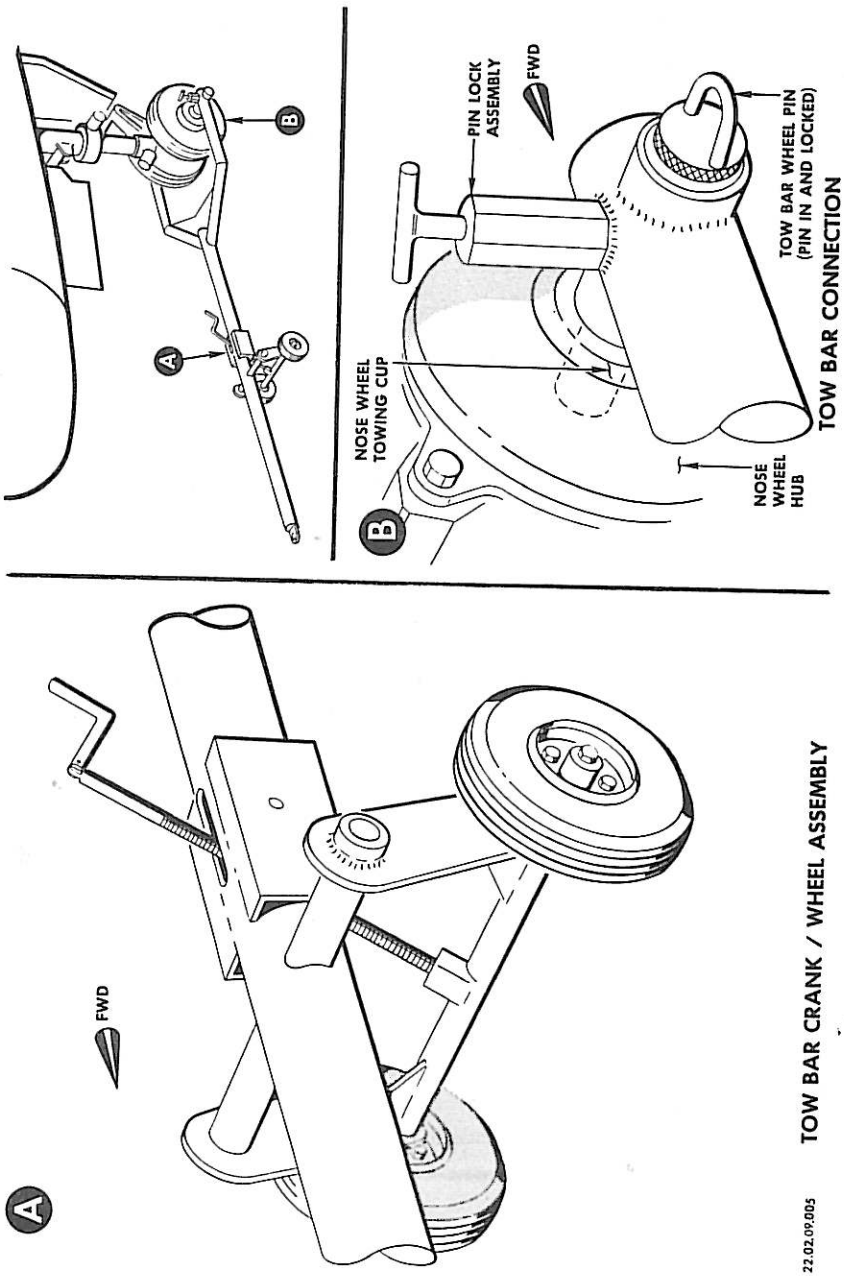
CAUTION: WHEN INSTALLING BALLAST IN THE FORWARD CARGO COMPARTMENT DO NOT EXCEED A MAXIMUM FLOOR LOAD OF 20 POUNDS PER CUBIC FOOT OR 100 POUNDS PER SQUARE FOOT.

2. Nose Gear Towing

Maintenance towing is generally accomplished on a hard, dry surface from the nose landing gear, as shown in Figure 1. The nose wheel steering linkage (torque arms) disconnect permits a swivel of 360 degrees; however, towing with the wheels turned at angles greater than 60 degrees will result in scuffing of the main gear tires and shall be avoided. Equipment required to tow from the nose gear consists of a tow bar (see Figure 2) and a towing tractor equipped with an electric power source. The electric power source is required to operate the airplane auxiliary hydraulic pump for wheel brake operation, and when necessary to furnish power for operation of the airplane air conditioning system and clearance lights. Four men shall be used when towing the airplane in congested areas: one in the flight compartment to operate the wheel brakes and attendant duties, one on the tractor, and one at each wing tip to check wing and tail clearances. The maximum towing load at the nose landing gear must not exceed 36,750 pounds in the fore and aft directions. The towing vehicle should be equipped with a torque converter transmission to provide smooth acceleration, thus eliminating excessive impact loads on the nose landing gear. Permissible loads that may be applied to the nose landing gear vary depending on the turn angle of the nose wheel. As an example, with the nose wheel



Towing from the Nose Gear
Figure 1


B
A
PIN LOCK ASSEMBLY
FWD
TOW BAR WHEEL PIN (PIN IN AND LOCKED)
NOSE WHEEL TOWING CUP
NOSE WHEEL HUB
B
TOW BAR CONNECTION
FWD
A
22.02.09.005
TOW BAR CRANK / WHEEL ASSEMBLY

at 90 degrees from center, a maximum load of 21,000 pounds shall not be exceeded. These load limits shall not be exceeded to preclude the possibility of damage to the strut and fuselage structure.

3. Main Gear Towing

The Convair 990 incorporates integral towing lugs on the front and rear of the main landing gear trucks, as shown in Figure 3. By using a manila rope or aircraft cable on both main gears, towing can be accomplished either forward or backward in mud, snow, or over rough terrain. The combined strength of the main gears will withstand considerable stress and strain as compared to the nose gear. The maximum towing load (applied either fore or aft) at each main landing gear must not exceed 27,500 pounds. When towing under adverse conditions make sure that both tractor operators coordinate their towing efforts. Coordination of the tractors will minimize the possibility of applying uneven or twisting loads to the airplane structure and main landing gear. Towing at an angle from the main landing gears shall be avoided.

4. Safety Precautions

A. General.

The following precautions must be checked and/or accomplished prior to towing airplane.

(1) Nose and main landing gear down-lock safety pins must be installed.

(2) Nose landing gear linkage (torque arms) must be disconnected at torque arm quick-disconnect. The torque arm quick-disconnect is released by pulling "tee" handle located at apex of the torque arms.

(3) Hydraulic hose and electrical harness quick-disconnects at apex of the nose landing gear torque arms must be disconnected.

(4) Headset and microphone or combination headset-microphone must be provided for communication between tractor operator and the man in flight compartment.

(5) The immediate area around airplane must be clear of all equipment and material prior to towing airplane.

Six persons are required when towing from the main landing gear -- one in the flight compartment for wheel brake operation and attendant duties, one to handle the nose landing gear tow bar to steer the airplane, one operator for each of the two towing tractors, and one at each wing tip to check for wing and tail clearances.

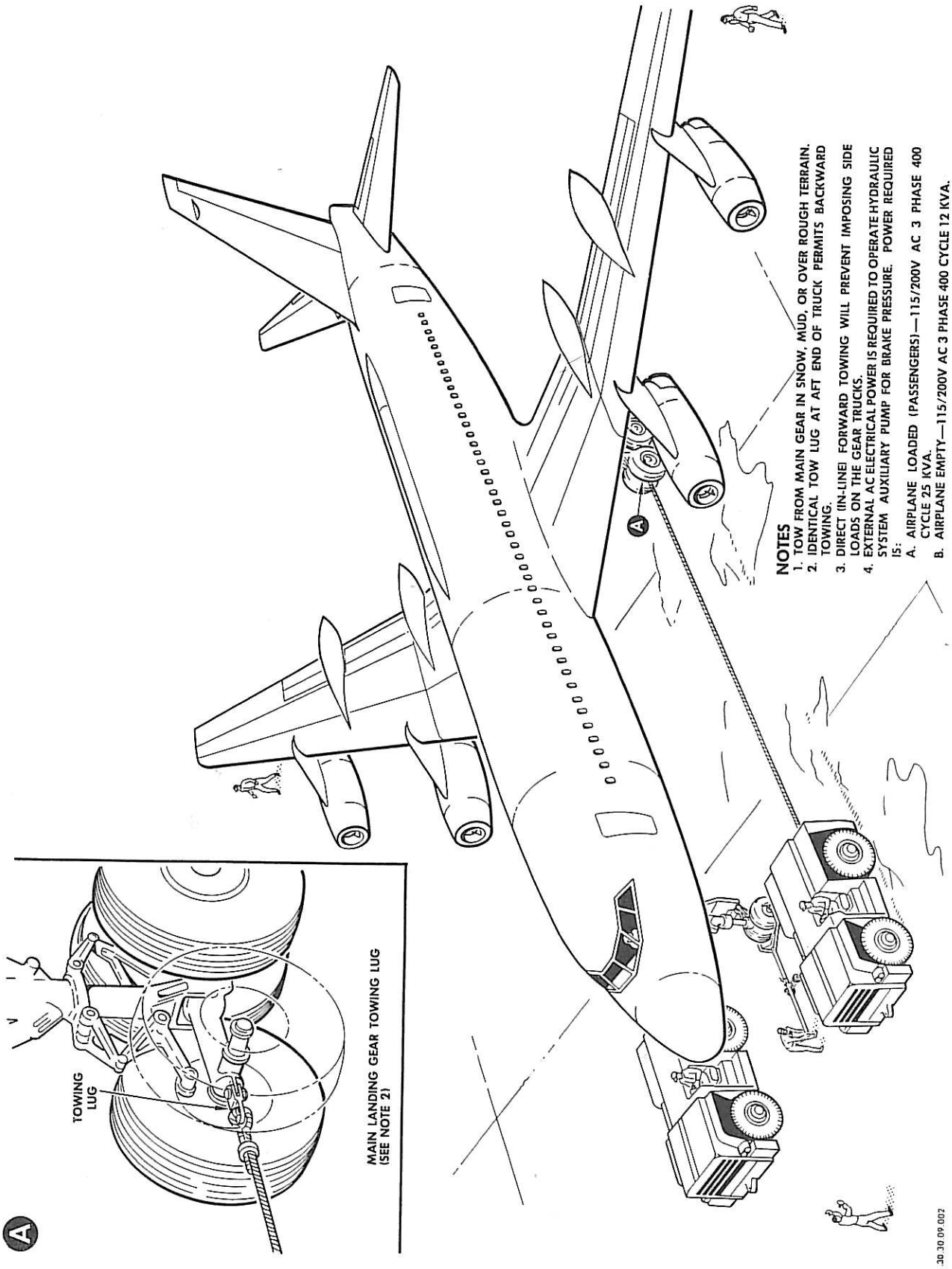

NOTES
1. TOW FROM MAIN GEAR IN SNOW, MUD, OR OVER ROUGH TERRAIN.
2. IDENTICAL TOW LUG AT AFT END OF TRUCK PERMITS BACKWARD TOWING.
3. DIRECT (IN-LINE) FORWARD TOWING WILL PREVENT IMPOSING SIDE LOADS ON THE GEAR TRUCKS.
4. EXTERNAL AC ELECTRICAL POWER IS REQUIRED TO OPERATE HYDRAULIC SYSTEM AUXILIARY PUMP FOR BRAKE PRESSURE. POWER REQUIRED IS:
A. AIRPLANE LOADED (PASSENGERS)—115/200V AC 3 PHASE 400 CYCLE 25 KVA.
B. AIRPLANE EMPTY—115/200V AC 3 PHASE 400 CYCLE 12 KVA.
A
TOWING LUG
MAIN LANDING GEAR TOWING LUG (SEE NOTE 2)
A
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TABLE I

Permissible Center of Gravity Configurations for Conducting Various Maintenance Practices

	CONDITIONS	WEIGHT (POUNDS)	ARM (STATION)	"A"	"B"
1.	Certified Weight Empty (CWE)	113,000	901.0	15	---
2.	CWE less one inbd. engine	108,224	908.4	5	---
3.	CWE less two inbd. engines	103,448	916.5	0	1100
4.	CWE less four engines	98,896	916.2	0	950
5.	CWE less two inbd. engines, electronics compt. empty, pilots' seats removed	100,259	928.2	0	3900
6.	CWE less four engines, electronics compt. empty, fwd. seats removed	90,707	929.1	0	3700
7.	CWE less two inbd. engines, plug full wing fuel	175,968	901.5	22	---
8.	CWE less four engines, plus full wing fuel	166,416	900.5	23	---
9.	CWE less two inbd. engines, electronics compt. empty, fwd. seats removed plug full wing fuel	172, 779	908.0	0	---
10.	CWE less four engines, electronics compt. empty, fwd. seats removed, plug full wing fuel	163, 227	907.4	9	---

"A" Maximum No. of men (165 lbs. each) allowed aboard airplane (at approximately station 1420 without ballast in forward cargo compartment. For each additional man, add 200 pounds of ballast evenly distributed about center of forward cargo compartment.

"B" Ballast required (evenly distributed about center of forward cargo compartment) to move the cg to station 912.0 with no men aboard at approximately station 1420.

NOTE: The cg (arm) may be moved forward by the addition of fuel to the No. 2 of 3 tanks. Adding 1500 pounds of fuel to the No. 2 or 3 main tank will move the cg forward one inch.

CAUTION: WHEN INSTALLING BALLAST, DO NOT EXCEED THE MAXIMUM FLOOR LOADS AS INDICATED IN THE FORWARD CARGO COMPARTMENT° QUANTITY OF FUEL IN OUTBOARD TANKS MUST NEVER EXCEED QUANTITY OF FUEL IN INBOARD TANKS. CENTER OF GRAVITY MUST NEVER BE AFT OF STATION 912.0.

TOWING - MAINTENANCE PRACTICES

1. Nose Landing Gear Towing

A. General.

Towing the airplane is normally accomplished from the nose landing gear when the airplane is on hard, dry surfaces. Two maintenance personnel are required when towing the airplane from the nose landing gear; one in the flight compartment for wheel break operation and attendant duties and one to operate the towing tractor. When towing the airplane in congested areas, two additional personnel are required, one at each wing tip, to check for wing and tail clearances.

B. Equipment Required.

(1) Nose wheel tow bar (P/N 4PE-21334).

(2) 12,000 to 20,000 lb/dbp (draw bar pull) or equivalent towing tractor capable of supplying 115-volt, three-phase, 400 cps ac power.

(3) Head set and microphone for communications between tractor operator and man in flight compartment.

(4) Wheel chocks.

(5) Nose landing gear down-lock safety pin (Cleveland Pneumatic P/N 9992C-169).

(6) Main landing gear down-lock safety pins (2) (Cleveland Pneumatic P/N 9991C-388).

(7) Engine inlet and exhaust gas duct plugs (four each).

C. Nose Landing Gear Towing Procedure.

CAUTION: DO NOT TOW AIRPLANE WHEN CG IS AFT OF STATION 912 UNLESS BALLAST IS INSTALLED IN FORWARD CARGO COMPARTMENT TO PREVENT TAIL OF AIRPLANE FROM TIPPING DOWN.

(1) Clear all equipment and material from immediate area around airplane.

CAUTION: DURING MAINTENANCE OR TESTING OF THE AIRPLANE, THE ANTI-SKID SWITCH SHALL BE IN THE OFF POSITION IF THE LANDING GEAR GROUND SAFETY CIRCUIT BREAKERS ARE OPEN. IF THE ANTI-SKID SWITCH IS LEFT ON AND THE GROUND SAFETY CIRCUIT BREAKERS ARE OPEN, THE BRAKES ARE INOPERATIVE. IF THE SWITCH MUST BE ACTUATED TO THE ON POSITION, WHILE THE GROUND SAFETY CIRCUIT BREAKERS ARE OPEN, INSURE THAT THE AIRPLANE IS SECURELY CHOCKED.

(2) Check that engine inlet and exhaust duct plugs are installed (refer to Chapter 75, POWER PLANT).

(3) Check that nose and main landing gear down-lock safety pins are installed.

(4) Check that landing gear shock struts are properly inflated (refer to Chapter 12, SERVICING).

(5) Check that all tires are properly inflated (refer to Chapter 12, SERVICING).

(6) Assign one man to flight compartment for operating airplane brakes.

(7) Connect interphone communication headset and microphone to jack box in nose landing gear wheel well.

(8) Disconnect nose landing gear steering linkage per instructions placarded on torque arm.

(9) Disconnect nose landing gear hydraulic hose and electrical harness quick-disconnect support at apex of torque arm.

NOTE: Steps (10) and (11) need not be accomplished if nose wheel is to be turned at angles less than 90 degrees.

(10) Disconnect hydraulic hose and electrical harness quick-disconnect support at lower torque arm pivot point.

(11) Disconnect individual hydraulic hose and electrical harness quick-disconnects at anti-skid detector and jack support bracket. Protect hydraulic line and adapter fitting from contamination.

(12) Connect tow bar to towing cups on nose wheel axle and towing tractor.

(13) Connect towing tractor's external power source to airplane's external power receptacle (refer to Chapter 24, ELECTRICAL POWER).

(14) Pressurize airplane's hydraulic system using the auxiliary hydraulic pump (refer to Chapter 29, HYDRAULICS).

(15) Check that hydraulic brake system operates properly before towing.

NOTE: Do not actuate airplane's emergency brake system unless an actual emergency exists.

(16) Disconnect static ground cables from landing gear.

(17) Release parking brakes.

(18) Proceed with towing operation observing the following:

(a) When towing at night, or under restricted visibility, the airplane's anti-collision lights, position lights, pilots' instrument panel floodlights and flight compartment dome lights shall be turned on.

CAUTION: DO NOT EXCEED THE FOLLOWING MAXIMUM TOWING LOAD LIMITS:

NOSE WHEEL CENTERED FORE AND AFT - 36,750 POUNDS
NOSE WHEEL 45 DEGREES FROM CENTER - 36,750 POUNDS
NOSE WHEEL 90 DEGREES FROM CENTER - 26,000 POUNDS

(b) Maintain wheel chocks readily available during towing for emergency stops and/or in case airplane or tractor brakes fail.

CAUTION: AVOID TOWING AIRPLANE AT ANGLES GREATER THAN 50 DEGREES TO PREVENT EXCESSIVE SUCFFING OF MAIN LANDING GEAR TIRES. DO NOT TURN AIRPLANE WITH ONE LANDING GEAR TIRE STATIONARY. ALL WHEELS SHALL BE ROLLING DURING ANY MANEUVER.

D. Main Landing Gear Towing Procedure.

CAUTION: DURING MAINTENANCE OR TESTING OF THE AIRPLANE, THE ANTI-SKID SWITCH SHALL BE IN THE OFF POSITION IF THE LANDING GEAR GROUND CIRCUIT BREAKERS ARE OPEN. IF THE ANTI-SKID SWITCH IS LEFT ON AND THE GROUND SAFETY CIRCUIT BREAKERS ARE OPEN, THE BRAKES ARE INOPERATIVE. IF THE SWITCH MUST BE ACTUATED TO THE ON POSITION, WHILE THE GROUND SAFETY CIRCUIT BREAKERS ARE OPEN, INSURE THAT THE AIRPLANE IS SECURELY CHOCKED.

(1) Perform steps C.(1) through (11).

(2) Connect tow bar to towing cups on nose wheel axle.

(3) Connect manila rope or airplane towing cable to fore or aft towing lugs (depending on direction airplane is to be towed) on each main landing gear.

(4) Connect interphone communication headsets and microphones to jack boxes on inboard side of each inboard pylon.

(5) Perform steps C (13) through C (17).

(6) Using the nose landing gear tow bar for steering, proceed with towing operations observing the following:

(a) When towing at night, or under restricted visibility, the airplane's anti-collision lights, position lights, pilots' instrument panel floodlights and flight compartment dome lights shall be turned on.

CAUTION: DO NOT EXCEED MAXIMUM FORE OR AFT TOWING LOAD LIMIT OF 27,500 POUNDS AT EACH MAIN LANDING GEAR.

(b) Maintain wheel chocks readily available during towing for emergency stops and/or in case airplane or tractor brakes fail.

CAUTION: TO PREVENT EXCESSIVE SCUFFING OF MAIN LANDING GEAR TIRES, AVOID TOWING AIRPLANE WITH NOSE WHEEL TURNED MORE THAN 50 DEGREES FROM CENTER. DO NOT TURN AIRPLANE WITH ONE LANDING GEAR TIRE STATIONARY. ALL WHEELS SHALL BE ROLLING DURING ANY MANEUVER.

COORDINATE MOVEMENT OF BOTH TOWING TRACTORS TO PREVENT IMPOSING UNEVEN OR TWISTING LOADS ON AIRPLANE LANDING GEAR TRUCKS AND AIRPLANE STRUCTURE. MAINTAIN A STEADY LOAD ON TOWING ROPES OR CABLES TO PREVENT JERKING OF THE AIRPLANE.

WARNING: USE EXTREME CARE TO PREVENT AIRPLANE FROM OVERRIDING TOWING TRACTORS.

TAXIING - DESCRIPTION AND OPERATION

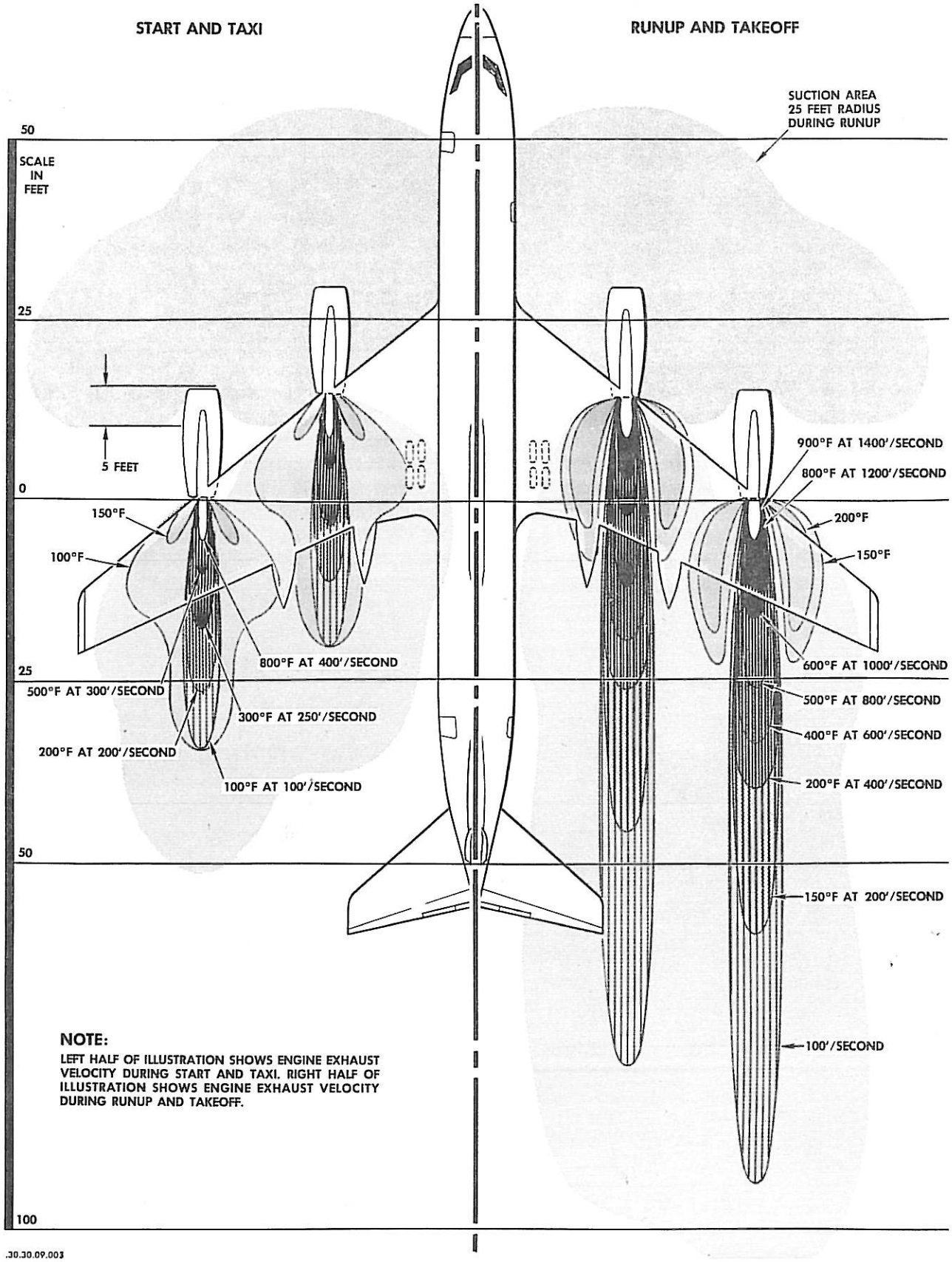
1. General

Taxiing procedures are utilized whenever the airplane must be moved from one area to another under its own power. The hydraulic system must be energized to actuate the nose wheel steering system and the wheel brakes.

2. Normal Taxiing Procedures

One, two, three or four engines, or any combination of engines can be used for taxiing. The engine or engines used for taxiing depends on the circumstances or as dictated by operator standard practices. To initiate a taxi roll, a minimum power setting which is sufficient to gain rolling momentum shall be used. Caution must be exercised when advancing power so as not to exceed the minimum thrust required since blast, heat and noise levels increase very rapidly when above 75 percent. Figure 1 illustrates the heat and blast danger areas of the engines.

The nose wheel steering system is rigged with mechanical stops which prevent turning the nose wheel more than 63 degrees to the left or right of neutral or center. With the nose wheel at an angle of 63 degrees, either left or right, the wing tip describes an arc of 85 feet six inches about the pivot point.



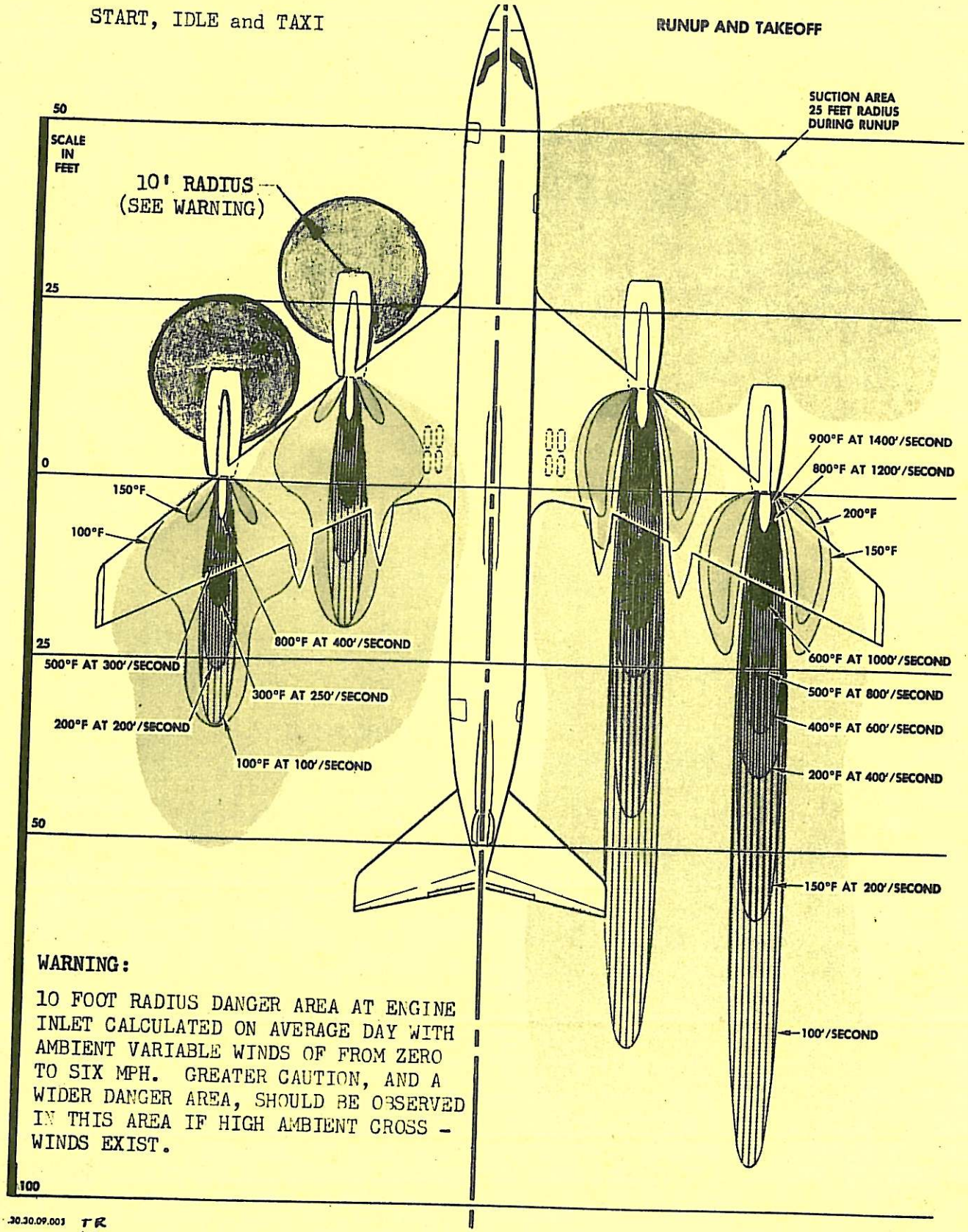
Engine Inlet and Exhaust Danger Areas
Figure 1

TEMPORARY REVISION NO. 9-1.
Insert facing 9-2-0, Page 2, dated Aug. 30/61.

This illustration supersedes the illustration on page 2.

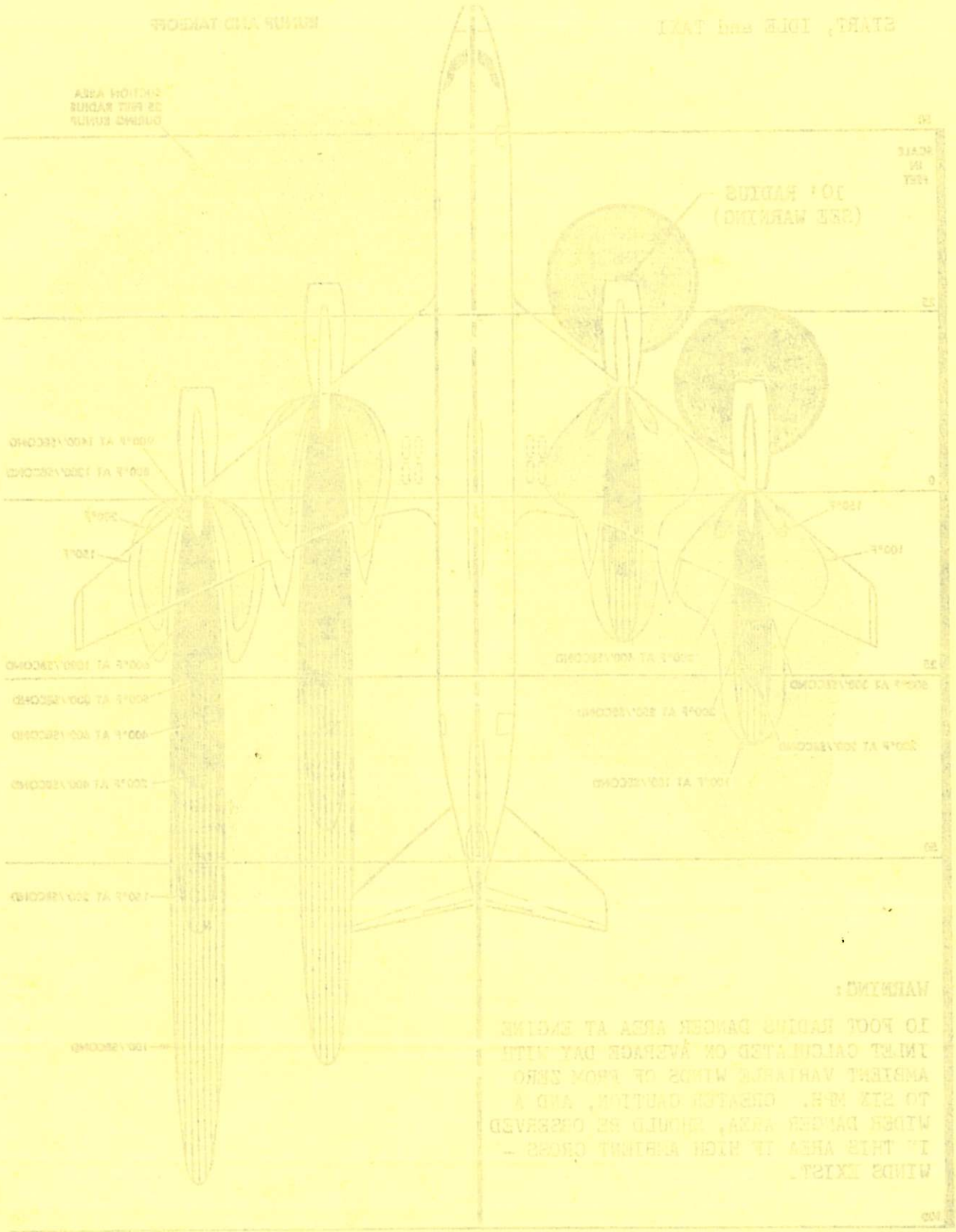
START, IDLE and TAXI

RUNUP AND TAKEOFF



WARNING:

10 FOOT RADIUS DANGER AREA AT ENGINE INLET CALCULATED ON AVERAGE DAY WITH AMBIENT VARIABLE WINDS OF FROM ZERO TO SIX MPH. GREATER CAUTION, AND A WIDER DANGER AREA, SHOULD BE OBSERVED IN THIS AREA IF HIGH AMBIENT CROSS - WINDS EXIST.



TAXIING - MAINTENANCE PRACTICES

1. Taxiing

A. The following practices must be observed at all times during taxiing procedures:

(1) Station ground control man in front of airplane within visual range of cockpit (ground man must be able to observe immediate area around airplane).

(2) Do not attempt to taxi airplane away from parking or maintenance areas without proper direction from ground control man.

NOTE: Communications between the ground control man and the cockpit shall be standard, operator-approved hand signals.

WARNING: GROUND CONTROL MAN SHALL NOT ALLOW THE AIRPLANE TO APPROACH HIM CLOSER THAN 50 FEET AT ANY TIME WITHOUT EXECUTING THE SIGNAL TO TURN OR STOP.

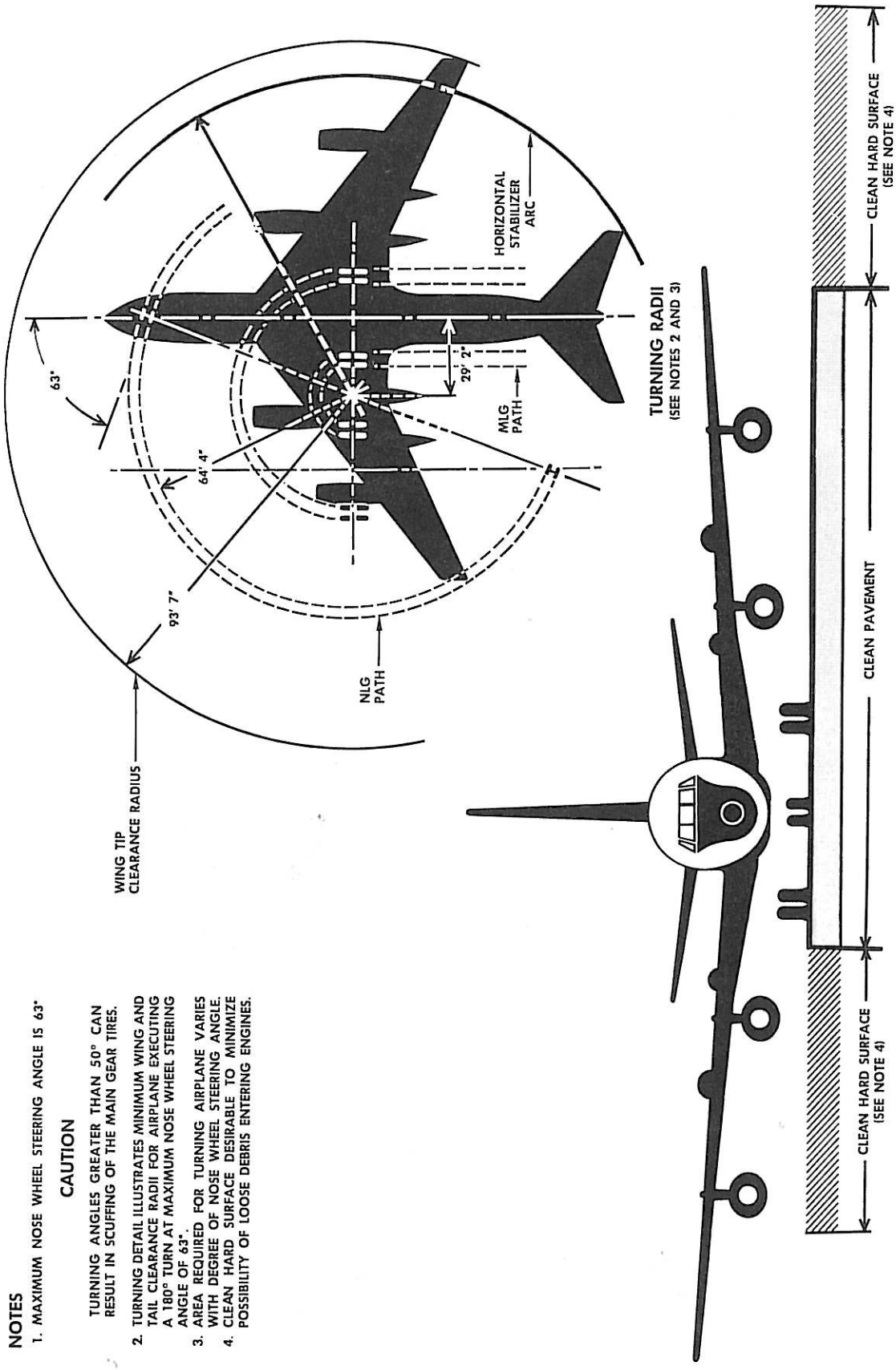
(3) Use only sufficient power to gain rolling momentum when taxiing airplane away from other airplanes, structures, or congested areas.

(4) When it is necessary to turn the airplane immediately after taxiing from parking or congested areas, obtain the required rolling momentum in a straight forward direction, reduce power, and accomplish the turn with power reduced to minimum.

WARNING: DO NOT TAXI AN AIRPLANE IN SUCH A MANNER THAT ENGINE EXHAUST BLAST CAN CAUSE INJURY TO PERSONNEL OR DAMAGE ADJACENT PROPERTY AND AIRPLANES (SEE FIGURE 1 FOR ENGINE INTAKE AND EXHAUST DANGER AREAS).

CAUTION: EXERCISE EXTREME CARE WHEN TURNING AIRPLANE TO ASSURE SUFFICIENT CLEARANCE WITH ADJACENT AIRPLANES AND STRUCTURES (SEE FIGURE 201 FOR MINIMUM TURNING LIMITS).

WARNING: DO NOT ALLOW PERSONNEL OR VEHICLES TO APPROACH AN ONCOMING TAXIING AIRPLANE OR PASS TO THE REAR OF THE AIRPLANE WITHIN 200 FEET.



NOTES

1. MAXIMUM NOSE WHEEL STEERING ANGLE IS 63°

CAUTION

TURNING ANGLES GREATER THAN 50° CAN RESULT IN SCUFFING OF THE MAIN GEAR TIRES.

2. TURNING DETAIL ILLUSTRATES MINIMUM WING AND TAIL CLEARANCE RADII FOR AIRPLANE EXECUTING A 180° TURN AT MAXIMUM NOSE WHEEL STEERING ANGLE OF 63°.
3. AREA REQUIRED FOR TURNING AIRPLANE VARIES WITH DEGREE OF NOSE WHEEL STEERING ANGLE.
4. CLEAN HARD SURFACE DESIRABLE TO MINIMIZE POSSIBILITY OF LOOSE DEBRIS ENTERING ENGINES.